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ON THE COLORED CORPUSCLES OF THE BLOOD OF PYRENÆMATOUS AND APYRENÆMATOUS VERTEBRATES. By George Gulliver, F.R.S.

My attention has been recalled to this subject by an interesting paper, on the blood-corpuscles of the two-toed sloth, by Professor Rolleston, published in the current number of the Microscopical Journal.

The author refers to a statement, by Dr W. Kühne, to the effect that, among Mammalia, the camel and sloth only have nucleated colored corpuscles of the blood; and to other writers, who say that such cells have been observed in more mammalia, and that colored blood-cells in size and shape resembling those of mammalia are found in certain oviparous vertebrates.

Of the sloth, Professor Rolleston and Mr H. N. Moseley observed, in a dried specimen of the blood, that though a certain number of the colored corpuscles contained one or more nuclei more or less roughly hewn, and irregularly and eccentrically placed, the immense majority of those corpuscles presented a non-nucleated character. And, in some stale blood of an elephant, which had died a week before the examination, Dr Rolleston notes many colored nucleated cells, in which the colored part was inside while the envelope was colorless.

Further observations are required to prove how far such phenomena may be due either to a solution and displacement of the coloring matter from commencing putrefaction, or to an irregular refraction of and interference in the light by disfigured and discolored parts of these decaying corpuscles. As it does not appear that the so-called nuclei were subjected to chemical examination, we are left in doubt as to their real character.

Apparent nuclei in colored corpuscles of the blood of mammalia vanish when treated with reagents which are powerless on the nuclei of the colored cells of oviparous vertebrates. But I do not pretend to assert that there are no exceptions. Colored corpuscles, apparently nucleated, are not uncommon in mammalia, but never regularly more than one or two of such nucleated corpuscles to a hundred of the characteristic non-nucleated corpuscles; and so scanty are the irregular ones, as to render a chemical examination of them a matter of difficulty. Concerning a few aberrant corpuscles in the blood of one or other species of this or that group of vertebrates, Professor Rolleston judiciously remarks that, "Here, as in so many other cases, the value of a structural arrangement depends, not upon an invariable presence or an invariable absence, but upon the constancy of its quantitative preponderance."

Just so. And I thought I had plainly proved, about a quarter of a century ago[1], that the blood-discs of camelidæ are, like those of other mammalia, devoid of a nucleus; and that, while all oviparous vertebrates have nucleated colored corpuscles, the class mammalia is most briefly and truly distinguished as *vertebrates with non-nucleated colored corpuscles of the blood.* Hence my divisions Vertebrata Pyrenæmata and Vertebrata Apyrenæmata (*πυρὴν* nucleus, *αἷμα* sanguis).

Both before and after the time referred to, the existence or non-existence of a nucleus in the colored corpuscle of the blood was a matter warmly debated, here and on the Continent. This was partly caused by mistakes arising from the biconcave shape of the mammalian corpuscle; and its disposition to rapid changes of form, either by tumidity, puckering, granulation, or more or less partial and irregular thickening of its substance; but chiefly from the then too common practice of applying to different classes observations true only of one or other of the two great divisions of vertebrates already mentioned. Hewson, having clearly demonstrated the nucleus in the colored cells of fishes and batrachia, never doubted that the central spot in the

[1] *Med. Chir. Trans.* Nov. 1839; *Phil. Mag.* 1840, pp. 30, 106-7; *Lancet*, 1840—1, Vol. II. p. 101; Appendix to Gerber's *Anatomy*, 8vo. Lond. 1842, pp. 18, 30, 100.

blood-discs of man and other Apyrenæmata was also a nucleus. Dr Young, Dr Hodgkin and Mr Lister having proved, on the contrary, the non-existence of a nucleus in the human colored corpuscle, came to a conclusion quite opposite to that of Hewson. There were other errors. For example, Sir Everard Home and Mr Bauer depicted what they called a nucleus in the mammalian corpuscle; adding some specious speculative and erroneous views, which were warmly embraced and long entertained on the Continent, but never favoured in Britain; save that, after their exportation abroad, they were imported back and made, much to my surprise then, a large part of the article on the blood in Dr Todd's valuable Cyclopædia of Anatomy. Dr Martin Barry, by the partial action of a very minute dose of acid on the colored corpuscles of man, produced an appearance which he declared to be that of a nucleus always plainly demonstrable by his process.

In Germany also, the most eminent physiologists had satisfied themselves and others of the nucleated character of these corpuscles. Müller believing, like Wagner, that their minuteness had caused the nucleus to escape attention, declared nevertheless how distinctly and really it might be demonstrated in the colored corpuscles of Man and mammalia; while Krause and Gerber likewise affirmed the presence of this nucleus in these corpuscles. A doubtful opinion only was arrived at on this point by Rudolph Wagner, of whose excellent *Elements of Physiology* a worthy English and annotated version appeared, under the care of Dr Willis, in 1844; and Wagner's hesitating views on the subject are the more remarkable, as he had admirably surpassed all his countrymen in the value and extent of his observations on the blood-discs of the different classes of vertebrates. But in France M. Donné, during the year 1842, dismissing such doubts, truly asserted the non-existence of a nucleus in the regular blood-disc of mammalia.

Lastly, in London, 1845, Mr Wharton Jones, describing the genesis of the red corpuscle of Apyrenæmata, and discussing what he appropriately called "this vexed question of a nucleus," fully agreed with me as to the essential difference of structure between the colored corpuscles in mammalia and the colored

cells in oviparous vertebrates. And at the same time he announced a difference in development, no less remarkable than the difference in the mature structure, between the colored corpuscles of these two great divisions of the vertebrate subkingdom.

But, as it appears, from Professor Rolleston's valuable paper, that this vexed question of a nucleus still lingers on the Continent, if not in Britain, I now propose to describe a few simple experiments which have always proved satisfactory to me concerning this important subject, and it is hoped will do so to others who may take the trouble to repeat them.

First, let us consider some of the plainest characters of the nucleus in question. In the colored corpuscle of most Pyrenæmata this nucleus is more or less rounded in form, and an ellipse of variable proportions; it is not only insoluble in water and in acetic acid, but is actually made more distinct under the action of this acid. When a single or thin layer of these colored blood-cells is dried on an object-plate, their nuclei, so far from being rendered invisible by the moisture of the breath, are more clearly brought into view after we have breathed upon this stratum of colored corpuscles; and so little are the nuclei prone to putrefaction, that they continue apparent long after the colored and pale cells and other forms in the blood have been destroyed by this process. The chemical characters of the nuclei of the blood-discs of Pyrenæmata, and the lymph-globules of Apyrenæmata and birds, are identical, excepting some curious minor points, as described and figured in my Lectures, reported in the *Medical Times and Gazette*, 1862-3. The lymph-globules I have always regarded and described as nuclei, and the pale globules of the blood as nucleated cells; but these two very different objects have been, and still are, commonly confounded, especially in Germany.

Of oviparous vertebrates, if we look at the fresh colored corpuscles swimming in the liquor sanguinis on an object-plate, a few of them may show their nuclei, and more not so. Add some water to this blood, and the majority of the cells will exhibit their nuclei. Treat another drop of the same blood with acetic acid, and the mass of the cells will disclose their

nuclei beautifully. Dry a fresh and very thin layer of the like blood on an object-plate, when some few nuclei may be visible; then breathe upon it, and the cells will soon be seen to be regularly nucleated, and perhaps some of the nuclei more or less tinged by displaced coloring matter. Finally, set a separate sample of this blood aside until the form of the cells has been destroyed by incipient putrefaction, when the nuclei will distinctly remain the chief morphological objects visible in the fluid. And thus these vertebrates belong to the Pyrenæmata.

Next repeat each of these experiments on the colored corpuscles of man and mammalia. The results, as far as regards nucleation, will be plainly in the negative. And thus these vertebrates belong to the Apyrenæmata.

It used to be argued, both in Britain and on the Continent, that the comparative minuteness of the blood-discs of man and mammalia was the cause that the still smaller nuclei escaped detection. But, after my discovery of the large size[1] of the colored corpuscles of the great ant-eater, two-toed sloth, and capybara, I searched them in vain for nuclei; when the results proved in this respect as completely negative as those obtained from other Apyrenæmata, including cetacea, marsupialia, and monotremata; while in certain birds with the colored corpuscles but a shade larger, and some rather smaller, than many of the

[1] In mammalia, Hewson concluded that there is no relation between the size of the animal and that of its blood-discs, because he found them much alike in the horse, mouse, cat, and bat. But, in one and the same natural family of this class, I have long since proved that there is such a relation; and the subsequent discovery of the large size of the blood-discs of the great ant-eater is to the like effect. There are orders, *e.g.* Ruminantia and Edentata, characterized either by the smallness or largeness of their blood-discs; and the largest of these corpuscles yet known in the latter order occur in this big member of it. On the same ground, it is probable that the colored corpuscles of such immense Edentata as the megatherium, were larger than any ever yet seen in mammalia. In short, as a rule, the largest blood-discs will be found in the large species, and the smallest in the small species of a natural family of mammalia. A few apparent exceptions there are to prove the rule; but these, even in the present imperfect state of our knowledge of the disturbing conditions, will be sometimes explicable in connection with special circumstances in the economy of the animal, which should be studied in the light of the admirable observations of the illustrious physiologist Milne Edwards. See *Medical Times and Gazette*, Nov. 8, 1862, page 484.

colored corpuscles of the ant-eater, the nuclei were always very plainly seen. Nor could I ever find that either the large circular colored corpuscles of the elephant, or the smaller oval ones of the camels, afford any exception to the non-nucleated character of the colored corpuscles of mammalia. Many experiments were made by me on the blood and lymph of these animals, quickly after the discovery by Mandl of the large size of the elephant's corpuscles and the oval form of those of the dromedary, and my own discovery, in 1839, of this oval shape in the blood-discs of the llama, vicugna, and Bactrian camel, and the singular minuteness of the blood-discs of the musk-deer. Though these last are the smallest colored corpuscles known in vertebrates, the lymph-globules, both of this animal and of the camels, were found to be nearly of the same size and of the same form as in other Apyrenæmata, including the elephant, of which animal an opportunity of examining the lymph did not occur until several years after I had satisfied myself concerning the point in question, as to the structure of the colored corpuscles of his blood.

The characteristic of mammalia as Apyrenæmata—vertebrates with non-nucleated colored corpuscles of the blood—though so very short, is simple, fundamental, and comprehensive. It is true at all stages of the existence of the species, from birth and during most of the time of intra-uterine life, and in both sexes. As of no other single diagnostic can as much be said, so it must, sooner or later, be in general use in systematic zoology. And though this is but a primary division of vertebrates, no doubt other and minor characteristics will be found in their blood-corpuscles; many of which I have noticed in various communications published long since in the proceedings of the Zoological Society, and more recently in the number of that work for February, 1862[1], as well as in my Lectures on the blood, chyle, and lymph, reported in the *Medical Times and Gazette*, 1862-3. In the proceedings of the Zoological Society for 1854, I pointed out that, excepting the elephant,

[1] Of the different classes of vertebrates, the engraving given in that memoir of the colored corpuscles all done to one scale, if further exactly enlarged to a sufficient size, would make a very useful diagram for lectures.

the great ant-eater could be easily distinguished by the colored corpuscles alone from any other animal then in the Gardens of the Society. Nor is it doubtful that the structure and function of vegetable cells, though now so lamentably neglected in the diagnoses of allied orders of plants, will prove less useful as truly natural characters in systematic botany, as shown in the *Popular Science Review* for October, 1865, where an epitome will be found of an extensive series of my researches on this subject.

Finally, it is hoped that the fore-mentioned tests may be fairly tried before any anatomist will again attempt to characterise the sloth and camel, or any other apyrenæmatous vertebrate, as an exception to the rule of its class in regard to the structure of the colored corpuscles of the blood. And to Dr W. Kühne, who is a writer on physiological chemistry, such experiments might be both easy and profitable.

Though the colored corpuscle of the blood of Apyrenæmata is commonly called indifferently either a cell or a nucleus, the correctness of these appellations thus used may be questionable. That corpuscle has regularly neither the nucleus of a cell, nor the chemical and physical characters of a nucleus, whatever truth may be in the careful and original observations of Mr Wharton Jones, before mentioned, as to the genesis of the apyrenæmatous corpuscle. In reality, the colored corpuscle of Apyrenæmata is quite a peculiar body, without a known equivalent or homologue, as a preponderating organism in the blood, among any of the lower classes of the vertebrate subkingdom. And the import of this fundamental fact in systematic zoology I have already described.

EDENBRIDGE, KENT,
June 6, 1867.

ON THE NATURE OF THE CORONOID PORTION OF THE PRONATOR RADII TERES. By ALEXANDER MACALISTER, M.D., L.R.C.S., *Demonstrator of Anatomy at the Royal College of Surgeons, Ireland.*

As a general rule the observation made by Meckel may be adopted as a definite anatomical law, that whenever a muscle presents two or more separate heads of origin, unless when these are the result of the splitting of a single part, it indicates development from several distinct embryonic germs; and in cases of this kind we usually find that when these parts are traced either in their normal states in the lower animals or in their occasional variations in man, such modifications of arrangement are manifested as clearly to indicate the probability of the proposition. An illustration of the truth of this law obtains in the case of the coronoid origin usually associated with the pronator radii teres muscle, a slip which in man very frequently presents us with many varying conditions of course and attachment. In the great majority of human upper extremities we find this second head of the pronator to consist of a flat tendinous slip springing from the inner side of the coronoid process of the ulna, internal to the insertion of the brachialis anticus, with which it is often closely connected, and of which, in a few instances, I have seen it as an offshoot. It is most commonly separated from the condyloid origin by the median nerve, which it separates from the ulnar artery. It unites with the rest of the pronator at an acute angle, usually of about 10°, more acute in the relaxed than in the contracted condition.

Sometimes its tendinous fibres become fleshy before uniting with the remainder of the muscular belly; but more frequently it remains as a tendon until merged in the condyloid portion. In either case the fleshy fibres continuous with this origin are situated deeper than the rest of the muscle. It does not seem to be an essential part of the pronator muscle, for in some cases, in man, it is absent; and I have seen, during the past

session, one specimen in which this muscle presented a complete cleft throughout. The coronoid portion in that instance was perfectly in its whole length separate and situated under cover of the condyloid; and it was inserted into the front of the radius higher up than the rest of the mass. This variation has been described by Meckel as a double pronator teres.

The coronoid fascicle, in comparatively numerous instances, has been errant in its insertion. I have seen four instances in which it was connected with the *palmaris longus*, in three cases forming a second and supernumerary origin of the palmaris, and in one case being the only superior attachment of that muscle. In all these it preserved its tendinous character perfectly, and likewise its usual relative position to the pronator radii teres, although no vestige of a second head for that muscle existed. Much more frequently the coronoid slip strikes into the substance of the *flexor carpi radialis;* and of this variety during the past session (1866—7), I have seen three examples. In one of them this coronoid origin of the flexor was separated from the condyloid origin by the brachial artery and median nerve, as in an instance elsewhere described (*Proc. R. I. A.*, 1866, April). In another, the median nerve alone passed between the two heads. In a remarkable specimen of this variety, the pronator radii teres had a tricipital origin, one slip springing from the tendon of the biceps, one from the internal intermuscular septum, and a third, a smaller band, from the internal condyle; but there was no fascicle from the coronoid. In one instance a single slip arising from this process was split at its insertion, and sent one band to the pronator teres, and another to the flexor carpi radialis.

Regarding the comparative anatomy of the coronoid slip, it will be found very rarely, if ever, developed in the lower animals; and respecting it, Cuvier, Meckel, and most other comparative anatomists, say nothing. I have not found it to exist in Cebus capucinus, Cercopithecus, Macacus nemestrinus or Sinicus, among Quadrumana[1], nor have I seen it in the examples

[1] [In a chimpanzee I found the coronoid portion disposed as in man, with the median nerve passing between it and the condyloid part. G. M. H.]

of Ruminantia, Pachydermata or Cetacea, which I have examined. Among the Carnivora, I have not found it in the brown Bear, Lion, Seal, Dog or Cat. Of the other mammalians, it is not present in any of the Rodents which I have examined; but I have not had any opportunity of looking for its existence in any of the Edentata. It seems thus to be a muscle peculiarly human in its nature.

We can thus arrive at the following deductions from the anatomical facts just noticed; 1st, that the coronoid slip is a product of a second or accessory embryonic germ, distinct from the rest of the pronator muscle; 2nd, that its usual connection with the latter muscle may be looked upon as the result of a partial suppression of this element, accompanied by coalescence with the nearest developed organs. As however Comparative Anatomy does not show us any reason for the existence of this structure, we will examine into its homotypical relations in order to ascertain whether or not any reason may be assigned for its existence based upon the nature of the structures developed in the pelvic extremity. In examining these structures in the hinder limb we find the two superior condyloid muscles, the representatives of the supinator longus and pronator teres, united in the inner and outer origins of the gastrocnemius. Beneath these we have the popliteus, which is the prolonged representative of the supinator brevis; and as this reaches the inner or tibial side of the limb, it displaces downwards the other muscular attachments from the upper part of this bone; and thus from the back of the tibia, below the popliteus muscle and connected to the fascial investment derived from the semi-membranosus (homotypical with the brachialis anticus), we have springing a muscular or tendinous band forming the inner head of the solæus. Now that this is the posterior equivalent of the coronoid slip seems clear as its attachments are homotypical, namely, from the posterior surface of the head of the tibia, below the insertion of the semimembranosus (immediately below the attachment of the fascial offshoot of that muscle which is inserted into the linea poplitæa); this inner head in man is united by a tendinous arch with the external parts of the same muscle; but in some rare cases is separable

from it for a considerable part of its course. It usually contributes a little less than two-fifths of the entire mass of the *solæus*, but in the animal kingdom is by no means constant in its occurrence. The Quadrumana[1] that I have examined present it as a very small portion of the muscle usually purely tendinous, and sometimes merely fascial. Of the quadrupedal mammalia, the Seal is the only animal in which, to my knowledge, it is distinctly present; and in it, as in the fore-limb of man, the tibial fasciculus unites directly with the inner head of the *gastrocnemius*, and no fibular part of the solæus exists. In most other mammals the outer head of the solæus alone is to be found, with nought save a slender fascial attachment to the tibia to indicate a second origin. Homotypical Anatomy thus gives us but little light as to the nature of the fasciculus; and from all these considerations we can learn only that it is a germ more distinctly and constantly present in man than in any other of the class Mammalia. Its real affinities may however be understood in regard to the law of symmetry which has so universal application to all parts of the typical animal; for in it we may recognize the germ of a superior transverse muscle, the upper equivalent and co-ordinate of the pronator quadratus below. This theoretical explanation is borne out, as well from its course in those anomalous cases of separation from the neighbouring muscles quoted above, as from the probability deduced by analogy that such a muscle would exist; and in the examples of isolation I have always seen it inserted higher up on the radius, although arising far below the level of the greater or condyloid fascicle of fibres; and thus its course was always more transverse than that of the superficial head which overlays it. That it is not an essential part of the carpal mass of muscle is shown by its rare coalescence with the flexor carpi radialis, and, in the lower limb, by its very infrequent presence as an accessory to the gastrocnemial mass; so its hypothetical nature, as suggested above, is not improbably its true

[1] [In the chimpanzee above-mentioned the tibial origin of the solæus was present as in man. In another chimpanzee it was absent, the origin of the solæus being confined to the fibula. In this instance I unfortunately omitted to note the origin of the pronator teres. G. M. H.]

one. Some kind of idea of the same kind seems to have been hinted at by Meckel when he says that the solæus represents the pronator quadratus; but as other relationships may with greater probability be assigned to that muscle, and as another homotype may be found for the pronator quadratus, the theory of the nature of the coronoid portion of the pronator teres stated above has some considerable degree of probability.

FOVEA CENTRALIS IN THE EYE OF THE FISH[1].

I know not whether such good observations as those of Mr Hulke, on the Fovea centralis retinæ of the chameleon, have been extended to fishes, nor indeed whether the part has been discovered in this class of vertebrates. At present I am not likely to have an opportunity of searching for any recent records of the subject. Examining in a rough way, without the aid of a microscope, the eyes of certain Sparidæ, the structure in question appeared to me so very large and remarkable as to be well fitted for the inquiry; and anatomists at the South Coast might find, as I have often done, abundance of the immense eyes of the common Sea Bream (*Pagellus centrodontus,* Cuvier et Valenciennes) quite fresh and inviting examination.

G. GULLIVER.

Aug. 1867.

[[1] The fovea centralis has not, I believe, been hitherto observed in the eye of the fish. G. M. H.]

CASE IN WHICH THE INNOMINATE VEINS OPENED SEPARATELY INTO THE RIGHT AURICLE, AND IN WHICH THE INTESTINES WERE MISPLACED; WITH REMARKS ON THE DEVELOPMENT OF THE PARTS. By JOHN CHIENE, M.D., *Demonstrator of Anatomy in the University of Edinburgh.*

A MIDDLE aged, female subject, dissected last winter, in the Anatomical Rooms of the University of Edinburgh, exhibited several interesting malformations, a brief account of which may prove instructive.

The right innominate vein, which received the right inferior thyroid, superior intercostal and the greater azygos veins, opened into the upper and back part of the right auricle in the usual position of the superior vena cava. The left innominate vein descended in front of the aortic arch and root of the left lung, disappeared behind the left auricular appendage, ran obliquely across the posterior wall of the left auricle to the auriculo-ventricular groove, and opened into the right auricle to the left of the orifice of the inferior vena cava, at the place where the coronary sinus terminates in a normal heart. There was no valve at its mouth. The vein was joined by the left inferior thyroid vein and left superior intercostal, the latter coming forward immediately above the root of the lung. It increased greatly in size when it reached the heart, where it received the great coronary vein and the middle and posterior cardiac veins, as in the case described by Mr Marshall (*Phil. Trans.* 1850). The two innominate veins were joined together by a slender transverse branch, which crossed obliquely in front of the great arteries opposite their origins from the arch. The Eustachian valve was rudimentary and cribriform. In all particulars this case corresponds to that described and figured by Mr Marshall, but differs, in the absence of a separate coronary opening and in the presence of an imperfect Eustachian valve, from the case described by Prof. Humphry, of Cambridge, in the first number of this Journal. Adopting the explanation given by Mr Mar-

shall, of the mode of origin of these irregularities, we may say that the persistence of the fœtal condition, which this case exemplifies, is due to the imperfect development of the transverse communicating branch between the primitive jugular veins and the consequent non-obliteration of the left Duct of Cuvier.

In the abdomen the arrangement of the viscera was as follows. The stomach was natural. From its pyloric end the duodenum passed upwards into the right hypochondrium, and then, sweeping downwards into the right lumbar region, became continuous with the jejunum without crossing from right to left in front of the aorta. The coils of the small intestine, which was 19 feet long, occupied the right and middle regions of the abdomen; and from the pylorus to the end of the ileum a well marked mesentery connected the small intestine to the posterior wall of the abdomen. The bile-duct opened into the duodenum 3¼ inches from the pylorus. The cœcum was not lodged in the right iliac fossa, but lay loose in the cavity of the abdomen, a meso-cœcum, five inches broad, directly continuous with the mesentery, passed to the surface of the last lumbar vertebra. The colon, twisted on itself and not subdivided into an ascending and a transverse portion, lay to the left of the middle line, and was continuous with the descending colon and sigmoid flexure which occupied their proper regions. A well marked meso-colon was connected to the posterior aspect of the entire length of the colon, so that the latter, like the cœcum, was very mobile. The parietal peritoneum was consequently prolonged continuously over the iliac fasciæ and the anterior surfaces of the kidneys. At the root of the meso-colon the peritoneum was puckered and presented the appearance of a large *cicatrix* both on the upper and under surfaces; but the two peritoneal layers were readily separable, the colic arteries passing between them. The great omentum was prolonged downwards from the lower border of the stomach, its posterior recurrent layers passed backwards to the spine, where they separated, one ascended in front of the pancreas to the diaphragm, the other descended and became continuous with the left (anterior) layer of the mesentery and meso-colon. The parietal peritoneum lining the right lumbar region was continuous with the right (posterior)

layer of the mesentery and meso-cœcum, whilst the corresponding structure on the left side was continuous with the left (anterior) layer. The length of the large intestine was five feet. The superior mesenteric artery arose as usual, descended behind the pancreas and between the layers of the mesentery arching downwards and to the right. From its right or concave aspect ten branches (*vasa intestini tenuis*) arose, which were distributed to the jejunum and ileum. From its left or convex aspect three arteries arose, the lowest (*ileo-colica*) of considerable size, the other two much more slender. The lower of these (*colica dextra*) passed downwards for four inches before it bifurcated to form the usual mesenteric arches; it was distributed to the colon. The upper (*colica media*) 1¾ inch long joined, without bifurcating, the branch (*colica sinistra*) of the inferior mesenteric which supplied the descending colon. The gastro-duodenal artery arose from the superior mesenteric, gave off a branch to the liver, and then divided into the right gastro-epiploic and a large pancreatico-duodenal artery.

The spleen was subdivided into five distinct portions, two were lobulated, and each measured three inches by two; the remaining three were small accessory lobes. This great subdivision of the organ is rare. The other viscera were normal.

With a view to an explanation of the peculiar position of the duodenum in this case, I have examined five human fœtuses from the 12th to the 18th week. In all the stomach had assumed its horizontal position. The duodenum wound round behind the coiled mass of intestine (jejunum and ileum) from right to left, and in all it was connected by a mesentery, more or less distinct, to the spine. In one this mesentery was one-fourth of an inch in breadth (the whole length of the fœtus was four inches), and was directly continuous with the mesentery of the jejunum. In this fœtus the cœcum lay to the left of the middle line. In three specimens the meso-duodenum, although less distinctly marked, having apparently become blended with the under surface of the mesentery of the rest of the small intestine, could still be seen connecting the transverse portion of the duodenum to the spine. In these the cœcum had passed to the right of the middle line, but had not yet

crossed in front of the duodenum. In these four cases on turning up the jejunum and ileum, which at this period lie closely coiled together in one mass in the middle of the abdominal cavity, the whole of the transverse portion of the duodenum was visible; in the fifth specimen in which the cœcum had passed over the duodenum and come into relation with the parietal peritoneum in the right lumbar region, the duodenum was not visible throughout its entire extent. In all, the parietal peritoneum, after lining the right lumbar region and the right iliac fossa, was continuous with the right side of the descending sigmoid meso-colon.

In the early embryo, as is well known, the intestinal tube is attached to the anterior surface of the spine by a double fold of peritoneum called 'meso-gastrium.' This is one continuous membrane; and the changes which afterwards take place in the position of any portion of the intestines must necessarily affect, more or less, every part of the membrane. That portion of the tube which is to form the stomach turns over on its right side and gradually assumes the horizontal position, its peritoneal fold becomes pendulous, and constitutes the great omentum. The pylorus and duodenum are thus carried to the right of the middle line. The cœcum now takes a position to the left of the middle line in the left lumbar region, and as it travels up, across, and down into the right iliac fossa, drags upon the small intestine and upon its attached mesentery, and, in consequence, a rotation or twisting (to the extent of half a circle, the centre of which is at a point corresponding to the origin of the superior mesenteric artery from the aorta) of the whole gut follows. This appears probable when we take into consideration the continuous nature of the meso-gastrium, the great change in the position of the cœcum, and the limited attachment of the mesentery to the spine. If this opinion as regards the position of the duodenum behind the jejunum and ileum is right, then its fixture there is easily accounted for. The cœcum having passed over the duodenum at the junction of its second and third parts and become related to the parietal peritoneum in the right lumbar region, binds the duodenum down to the spine, as we find it in the normal subject. It

then moves down and becomes fixed in the right iliac fossa. The more perfect this attachment is, the less is seen of the duodenum on turning up the intestines. In three cases of moveable cœcum and ascending colon which have lately occurred in the dissecting rooms, a greater extent of the transverse portion of the duodenum than usual could be seen. Whether a twisting of the whole tract takes place or not, the fixed position of the duodenum is undoubtedly dependent on the fact of the cœcum passing over it, and becoming lodged in the right iliac fossa.

In the case which I have described rotation had not taken place. The cicatrix, situated at the root of the meso-colon, and probably due to intra-uterine inflammation, had prevented the large intestine from moving across and down to its normal locality. The duodenum therefore remained free in the abdominal cavity.

The vascular anatomy seems to strengthen this idea. The superior mesenteric artery, instead of running from the mesial line to the right, passed to the left, and gave off the colic arteries from its left side and the arteries to the small intestine from its right, just the reverse of what we usually find. In the usual mode of dissecting this artery (by turning up the omentum and transverse colon and spreading out the small intestine), we remove what was primarily the *right* layer of the meso-gastrium; but in this case when the vessel was dissected, although done in apparently the ordinary way, the membrane removed was the *left* layer. Now, if we suppose a rotation of the intestine to occur, then the artery would assume the normal position.

The cœcum and large intestine having failed to reach their normal position, and an ascending and a transverse subdivision not having taken place, the transverse colon had not become permanently blended with the posterior recurrent layers of the great omentum, so that the passage back to the spine of this structure, which represents the meso-gastric fold in the embryo, could be demonstrated as entirely distinct from the transverse meso-colon. This case seems to support the idea, that the arrangement which we find in the normally developed adult,

where the recurrent layers of the great omentum are intimately united with the transverse colon and its meso-colon, is of secondary formation and produced by the blending of surfaces originally distinct, a view of the arrangement of the peritoneum which has only lately gained ground in this country, although described by Mr Holden in the first edition of his *Manual of Dissections* (1859). I may here mention that in the fœtuses, from the 12th to the 18th week, which I have examined, the transverse colon was intimately connected with the recurrent layers of the omentum, so that the blending of the transverse colon with the omentum must take place at an earlier period of intra-uterine life.

I take this opportunity of recording some cases of malposition of the large intestine in the adult which have occurred in the dissecting rooms since the series recorded in the *Edin. Med. Journal*, August 1863, by Professor Turner, to whom I am indebted for the following abstract: 1. A female. The cœcum was situated in the right hypochondriac and lumbar regions; the right iliac fossa was covered by the parietal peritoneum and the ileum passed through it to join the cœcum. 2. A male. The sigmoid flexure passed across to the right iliac region, where it was tied down by the peritoneum before it entered the pelvis to the right of the middle line. 3. A male. The cœcum and ascending colon were largely dilated and their coats thinned: they possessed a large mesentery and were freely moveable. The sigmoid flexure crossed to the right side and was tied down in the right iliac fossa, the peritoneum presenting a cicatrised appearance before it entered the pelvis on the right of the middle line. 4. A female. Not only the transverse and sigmoid parts of the colon but the ascending and descending portions and the cœcum had a distinct meso-colon, and were, therefore, freely moveable. The peritoneum was in close relation to the anterior surfaces and margin of the kidneys and permitted indeed slight changes in the position of the right kidney.

NOTES ON THE ANATOMY OF THE RETINA OF THE COMMON PORPOISE (*Phocæna communis*). BY J. W. HULKE, F.R.S. (Plate I.)

IN 1865, through the liberality of the Zootomical Committee of the Zoological Society, I received the eyes of a porpoise which had died soon after being placed in the gardens in Regent's Park. The bacillary layer of the retina was already too much spoiled to allow me to make out the exact forms of its elements, but the other layers were better preserved, and the unusual clearness of some details of their finer structure made me very desirous of continuing the examination. For want of proper material however I have never since been able to do so, and I communicate these fragmentary notes in the hope that they may lead others who have opportunities of procuring absolutely fresh eyes to study the retina of cetacea. I chiefly used sections of the retina previously hardened by chromic acid, tinted with carmine or rose-aniline, and rendered transparent with glycerine. These I compared with the same parts in the fresh retina without the addition of reagents; and I employed magnifying powers from 220 to 2000 linear. This may explain some differences between my account of the Porpoise's retina and that of Balæna Mysticetus published by Carl Ritter in 1864[1], which are greater than analogy would lead us to expect in animals of the same order.

For the study of the connective tissues (for which he strongly recommends the retina of Bal. Myst.) Ritter prefers preparations made by teazing; and he seems throughout to have used a magnifying power of about 300, with which I should have supposed it impossible to have recognized some of the finer details which he describes. With this he discovered that the fundamental element of the connective tissues is a two-branched cell, like a common spindle cell, only with blunter ends. The membrana limitans interna, as well as Müller's

[1] *Die Structur der Retina dargestellt nach Untersuchungen über das Walfischauge*, v. Dr Carl Ritter, Leipsic, 1864.

radial connective-tissue fibres springing from it, are, he says, constructed of special modifications of these cells, other transformations of which compose the intricate web that constitutes the special tissue of the granular layers, to which he gives the new name of the "Outer fibrous layer". In the optic nerve and ganglionic layers he tells us that the two-branched cells form a triple stage of meshes for the reception of the optic nerve bundles and the ganglion cells; and that in the inner granule layer they are built into a frame of cubic meshes three or four deep, and in this situation they undergo a most singular, glassy, membranous transformation, and exhibit cavernous hollows in which the granules lie. Schultze's membrana limitans externa is said by Ritter to be an illusory appearance of a membrane caused by the linear juxtaposition of the outer sides of the outermost series of these cubic meshes; and the inter-granule layer is disallowed as a distinct stratum on the ground of its alleged inconstancy in the Greenland whale and in other vertebrata. As regards the nervous structures, not having fresh specimens at his disposal, Ritter draws his account of the bacillary elements mainly from other vertebrates. They, of course, contain the axial thread discovered by our author. He states that the outer granules are not cells, either in the whale or in other higher animals, but only definite circumscribed accumulations of the contents inside the fibres produced inwards from the rods. The inner granules he describes as cells having several processes which on the outer side join those coming from the rods, and on the inner are continued into the fibres passing outwards from the ganglion cells. The last-mentioned cells are larger; they have a distinct nucleus, nucleolus, and a membranous wall.

In the retina of the porpoise, I found the same stratification as in the human retina. Its bacillary elements are small, slender and numerous as in the terrestrial mammalia. In profile their outer segments are long narrow rectangles. Their inner segments were already too swollen to allow me to determine whether rods and cones were both present, but I could distinctly see that these segments passed through the membrana limitans externa: and either included a near-lying

outer granule just inside the line of this membrane, or were prolonged to a more remote granule, as in other vertebrates. The outer granules (Fig. 1) are of more uniform size and smaller than the inner, their diameter ranged from $\frac{1}{9000}$ to $\frac{1}{8000}$ of an inch. In my chromic acid preparations they had a more homogeneous texture, and a high refractive index, but they were rather less strongly tinted by carmine than the inner granules.

The inner bacillary segment, or its prolongation, the primitive bacillary fibre, is produced inwards from its contained outer granule to the inter-granule layer, beyond which its demonstration is very difficult. The difficulty proceeds partly from the extreme delicacy of the fibre, and partly from the granular texture of the connective tissue-web, which is a large constituent of this layer. In my best sections, under a high power, the bacillary fibres on leaving the outer granule layer appeared to me to suddenly curve, and combining in bundles to enter the outer surface of the inter-granule layer, in which they pursued a curve nearly parallel with its surfaces, but slightly inclined towards the inner surface, where they escaped into the inner granule layer. The inclination was so slight that I could often trace a fibre continuously through the whole breadth of the field. The arrangement reminded me of that which obtains in the same stratum towards the periphery of the chameleon's retina, but I cannot say whether the direction of these fibres had any reference to a physiological centre, for the wrinkled state of the retina precluded a search for the fovea. In the inner granule layer the characters of the elementary nervous and connective tissues are strikingly obvious. The nervous cell-elements are distinctly cells (Fig. 2), they have a very definite and sharp though delicate outline, they are pale, their texture is very finely granular, and they contain a conspicuous nucleus which takes a deep stain from carmine. Many are clearly multipolar, giving off fine processes outwards towards the inter-granule layer, and sending others inwards into the granular layer. The former seemed to me to run into the plexus of bacillary fibres of which the inter-granule layer is largely formed, while the latter very plainly joined the pro-

cesses produced outwards from the ganglion cells of the proper ganglionic layer.

The other cell-elements in the inner granule layer are oval or irregular bodies of homogeneous aspect, without differentiation of parts, much smaller than the nervous granules (Fig. 3). They occur in the course of the connective radial fibres, or in intimate relation with the connective tissue frame in the spaces of which the larger granules lie. This frame is composed of stout septa, which passing across the inner granule layer from the granular to the inter-granule layer, in a radial direction from the centre of the globe, form large alveoli, which in turn are intersected by finer trabeculæ derived from the stouter partitions. The arrangement is very similar to that which we see in some birds and in chelonia. As the thickness of the inner granule layer is only half or a third of that of the outer granule layer, and the nervous inner granules are much larger than the outer, it follows that they are much less numerous than these.

The cells of the ganglionic layer (Fig. 4) are larger than in any other retina which I have yet examined. Some of them have a diameter of $\frac{1}{900}$ of an inch. Their shape is angular or roundly oval. They have a very sharply defined single outline, a finely granular rather opaque texture, and they all contain a very conspicuous more coarsely granular, and darker, constantly roundly oval nucleus, in which a nucleolus is generally visible. Many of these colossal cells are imbedded in the granular layer, near its inner surface. They detach numerous processess outwards which subdivide and cross the granular to the inner granule layer. These are more easily followed than in any other retina I know, and I distinctly traced their continuity with the fibres passing inwards from the inner granules. Other processes, fewer in number, pass from the ganglion cells to the bundles of optic nerve fibres.

The inner end of the optic nerve and the distribution of its bundles did not present any unusual arrangement. The former was a circular disc about 1‴ in diameter, and with an elevated edge, and a minute central depression corresponding to the human physiological pit. The sclerotic (Fig. 5) canal had a wide funnel

shape, the diameter at its outer end measuring 2¼‴, while that at its inner end measured but 1‴. This latter part only, corresponding to the inner fourth of the entire thickness of the sclerotic, embraced the trunk of the nerve at all closely, and furnished the lamina cribrosa, while behind this the increasingly wide interspace between the trunk of the nerve and the sides of the scleral canal was occupied by a prolongation of the vascular rete mirabile which surrounds the trunk outside the eyeball.

In the retina, in my chromic acid preparations, the nerve fibres had remarkably hard and sharp, single outlines, which made them unusually conspicuous, and they exhibited numerous fusiform swellings: of these as many as six might be seen in a single fibre in the course of $\frac{1}{50}''$. (Fig. 6.)

As regards the connective tissues I could not detect any trace of a compound structure in the membrana limitans interna, which appeared to me to be quite hyaline. Upon its inner surface (that towards the vitreous) humour there were traces of a pavement epithelium (2), while from its outer surface the fanlike bundles of the roots of Müller's connective tissue radial fibres arose in the usual way. These were soon gathered together and fused into stout columns which formed a series of arches (converse towards the granular layer), through which the nerve-bundles ran, and which also, outside these latter, enclosed those ganglion cells which were not embedded in the granular layer. At the inner surface of this latter many of the stout fibres composing the arcades rapidly broke up into increasingly fine fibrillæ, which constituted much of the proper tissue of the layer; while other fibres from the same source traversed the granular layer completely, and reached the inner granule layer, to the alveolar septa of which they contributed, and subdividing and becoming finer in their passage outwards, were lost in the finely granular tissue of the inter-granule layer. This layer was constant in all my sections (over 200), so that I cannot hesitate to regard it as a distinct stratum in the porpoise's retina, and I have found it equally constant in every vertebrate which I have examined. The proper tissue of the layer is an exceedingly fine connective tissue web, which, in sections, has a texture similar to that of the granular layer, but rather finer.

The thin stratum which it forms (about $\frac{1}{4}$ or $\frac{1}{8}$ as broad as the inner granule layer) is traversed radially from the centre of the globe by some of the terminal branches of Müller's radial fibres which pass into the inter-granule layer to lose themselves at the inner surface of the membrana limitans externa; while other fibres already described as nervous traverse it with only a very slight inclination from its outer towards its inner surface. The extreme regularity of the line and the parallelism of its outlines, which are conspicuous in vertical sections of hardened retina, and are also recognizable in folds of the perfectly fresh retina, do not appear to me consistent with Ritter's interpretation of the formation of the outer limiting membrane, and with Schultze I must still regard it as a membranous hyaline expansion pierced by numberless apertures for the inner segments of the rods and cones. Throughout the retina, in all the strata except the bacillary, the minute interstices between the elementary nervous tissues lying in the coarse connective tissue frame-are filled with an excessively delicate web of the latter tissue, as has been described by Schultze in other mammalia, and by myself in a former paper in this journal.

I was not able to resolve any part of these connective tissues into the fundamental two-branched cells described in Balæna by Ritter, so that while there is a general resemblance in their rough arrangement in the porpoise and in balæna there is an apparent difference in their ultimate constitution.

There is also another apparent difference in the distribution of the retinal blood-vessels in these two animals. In the Greenland whale, Ritter says, these vessels do not pass through the optic foramen, but through two special apertures in the sclerotic, an arrangement which appears very singular; while in the porpoise the trunk of the optic is traversed in the usual way by the vasa centralia, which at its inner end, within the eyeball, break up into branches which are distributed as far as the front of the retina. In the porpoise there are also large vascular canals near the optic foramen, but these transmit vessels passing between the choroid and the external rete mirabile.

EXPLANATION OF FIGURES.

Fig. 1. Outer granules, and membrana limitans externa. × 670.

Fig. 2. Nervous inner granules. *a.* Branched cell lying in an alveolus. *b.* Round and roundly oval cells close to the inner surface of the layers. *c.* Septum between two alveoli. *d.* Slightly inclined bundles of fibres in the inter-granule layer, believed to be passing from the outer to the inner granules. × 670.

Fig. 3. Nuclei of the connective tissues in the inner granule layer. × 670.

Fig. 4. Cells of the ganglionic layer. *a.* Outer processes going to the inner granules across the granular layer. *b.* Inner processes passing inwards amongst the bundles of optic nerve-fibres. *c.* An optic nerve fibre. × 800 nearly.

Fig. 5. A section through the back of the eyeball. × 2. *a.* The retina. *b.* The choroid. *c.* The sclerotic. *d.* The inner end of *e*, the optic nerve-trunk. *f.* Vascular canal in the sclerotic transmitting a vessel passing from the choroid into *g*, the Rete Mirabile, which is prolonged into the posterior part of the sclerotic canal.

Fig. 6. Optic nerve-fibres with fusiform varicosities. × 670.

ON THE ARRANGEMENT OF THE MUSCULAR FIBRES OF THE ALLIGATOR. By PHILIP HAIR, M.B. *Edinburgh.*

[THE following inquiry into the arrangement of the muscular fibres of the alligator was undertaken at the suggestion of the late Professor Goodsir, who provided the animals on which the dissections were made. It formed the substance of the author's *Thesis*, for which a gold medal was awarded by the Medical Faculty of the University of Edinburgh, on the occasion of his graduation in August 1866.]

THE muscles of the tail and back have been more especially examined; and a short description of the muscles of the lower part of the trunk and pelvic region has been appended, as there are some interesting arrangements in them.

The skin of the alligator is firmly attached to the subjacent muscles in the back and tail. In the caudal region this attachment is general, but in the back it is limited to a line corresponding to the articulation of the transverse processes of the vertebræ and the thoracic ribs. In the neck, abdomen, and extremities, the skin is comparatively loose and is connected to the superficial fascia. The muscles in the back lie behind the vertebræ, and are limited by the spines of the dorsal vertebræ on the one hand and the vertebral parts of the ribs on the other. The caudal muscles have a lateral position, and are subdivided into two sets, a 'dorsal' and a 'ventral.' The dorsal set lies between the spines and transverse processes of the vertebræ, becomes continuous with the general muscular mass of the back, and may be named the *Dorso-lateral* mass. The ventral set lies between the transverse processes and the chevron bones, passes to the root of the tail, becomes fixed to the inferior pelvic bones, and may be termed the *Ventro-lateral* mass.

A muscular mass, when examined *in situ*, before the dissection is carried so far as to illustrate its more composite arrangement, is seen to possess longitudinal bundles, which run

parallel with each other from the one end of the mass to the other, the number being definite, but not equal at every part of the mass. Thus at each end of a muscular mass two longitudinal bundles may only exist, but approaching the middle of the mass the number may be increased to three, then to four, and ultimately to five. More than this I have not seen. Five longitudinal bundles are found in the ventro-lateral mass, four in the dorso-lateral mass, and in the dorsal region proper four prevail throughout. The longitudinal bundles are not in contact with each other along the whole length of their course, but are separated by equidistant spaces, and are joined to one another by equidistant processes of muscular and tendinous tissue.

Each longitudinal bundle represents, on a small scale, the arrangements of the whole of the longitudinal bundles combined, and consequently the construction of the mass itself. If a longitudinal bundle be examined it will be found to have on its upper or outer aspect a number of transverse tendinous processes, the *inscriptiones tendineæ* (Stannius). They are developed along the whole of the bundle from one end to the other, and are equidistant from each other. Their distance exactly corresponds to the horny skin-plates externally, or to the length of the bodies of the vertebræ internally. They are segmental, or semicircular, with their concavities all turned in one direction. They come forwards as it were obliquely from the deeper part of the bundle to its more superficial or skin aspect, and are the representatives of the bases of cones, which are the more proximate constituents of the bundle. These cones are hollow, and the apices of one set appear to be enclosed within the bases of adjacent cones. For instance, if a sugar-cone were cut into two segments, and the interior of each segment hollowed out, then the one segment placed within the other would represent extremely well the arrangement of the cones. They vary in thickness, but not in length, at any part of the bundle. The cones seem flattened from before backwards, so that they appear somewhat triangular. From the base of each cone lateral processes of muscular and tendinous fibres proceed in an oblique direction, and pass on to join other conical

arrangements to be presently described. A cone seems, as far as I have been able to determine, to be of a triangular form,

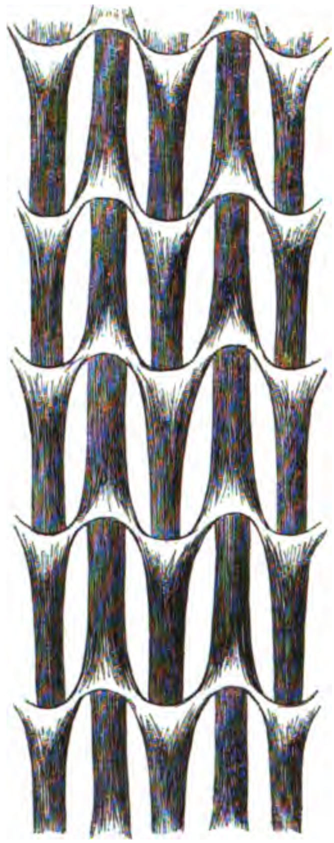

Fig. 1.[1]

the sides of which become doubled in upon themselves, especially at the apex of the triangle, which seems at that part to be solid, but nearer the base this incurvation is not carried to

[1] Fig. 1 represents the manner in which the cones are placed within each other to form a longitudinal series; the lateral connections of the longitudinal series with each other, and their alternating direction, are also diagrammatically represented. The arrangement of the cones in the manner indicated forms a typical muscle.

so great an extent, and consequently accounts for the hollow conical appearance at that part, which forms a receptacle for the succeeding cone. At the same time, it is continued further on by means of its sides, while its centre as it were stops short; so that, instead of having a straight base, it is crescentic in shape. A number of such cones placed within each other forms a longitudinal bundle, which on its external surface has the tendinous intersections already spoken of. But if the internal surface of such a bundle or series of cones be examined, it seems as if it were an entire longitudinal bundle, having projecting from each side, at regular intervals, muscular processes.

The apices do not appear as distinct on the inner surface as the bases do on the outer. Further, the apices do not terminate in the cones in which they are enclosed, but when their fibres have crossed each other, like the letter X, they partly end on a small tendon, or aponeurotic structure, which is attached to bone, and partly by passing into the cone in which it is enclosed. The base of each cone, as I have said, is crescentic; and the central portion of the crescent ends on a thin aponeurotic tendon, which is generally attached to the horny skin-plates. The horns of the crescent are disposed as follows. In cones from the outside of a muscular mass one horn is attached to the bone, while the other horn passes on to the cone of the neighbouring longitudinal series of cones; but in cones from the central bundles the horns pass into the cones of their respective sides. Such then being the mode of distribution of a single cone, I now proceed to notice the manner in which a number of them form a longitudinal bundle. This is effected by the cones being placed for some distance within one another. Consequently, all those which enter into the formation of a single bundle have the same direction. A second longitudinal bundle is formed in the same way as the first, its cones having all the same direction with reference to each other, but an opposite direction with regard to those of the first series. Suppose the cones of the first series to have their bases directed towards the head (and consequently their apices towards the tail), the cones of the second series would have their bases directed towards the tail and their apices towards

the head. In a third series of cones the bases would be turned in the same direction as those of the first series, and so on; alternating in the several series with each other, the length of the cones being the same in all. One bundle of cones however may be thicker than another, for the mass is not uniform in thickness throughout. Yet if we compare the bundles together we find that if the first series be thick and powerful, the second will be, as a general rule, thinner and weaker, and so on with the others; thus showing a tendency to alternate in size.

Erector spinæ commences by two longitudinal bundles from the last caudal vertebra. It lies in close contact with the bones beneath, and is firmly attached to the horny skin-plates externally by means of aponeurotic tendons, '*Inscriptiones tendineæ.*' It shows a tendency to the conical arrangement, but this is not easily distinguished until it reaches nearer the middle of the tail, when the conical form is unmistakeably seen. There the number of longitudinal bundles is increased to three. Higher up the number is four; and they have all more or less the conical arrangement. Opposite the iliac bones they are reduced to two; or if a third exist, it is central and very small compared with the other two. In the back a third row which is central appears. These preserve the conical arrangement along the whole of the back. They are accompanied by another muscle, the *Ilio-costalis,* which arises tendinous from the anterior part of the ilium, and passes up over the ribs external to their junction with the transverse processes of the vertebræ. It is fixed to all the ribs, and shows a tendency to the conical arrangement; but this appearance is not so well exemplified as in the longissimus-dorsi. It is connected internally to the longissimus-dorsi by means of aponeurotic tendons, and externally to the ribs by short narrow tendons. It is continued into the neck as the *Cervicalis ascendens,* which is inserted into the 4 or 5 lower cervical ribs. It may be considered as continued on to the skull, by a small muscle, which arising from the second and third cervical ribs, is inserted into the mastoid process of the skull. The muscular mass of the tail is principally made up of the backward prolongation of the

spinalis and longissimus-dorsi. The latter constitutes by far the largest portion; both have well marked cones, which freely communicate with each other along the whole extent.

The *Longissimus-dorsi* is the external portion of the tail mass. It lies close to the sides of the vertebræ at the hinder part of the tail, being attached first to the bodies of the vertebræ, and then to the upper surfaces of the transverse processes. It consists of three series of longitudinal cones, which increase in size until they reach the iliac bone, where they join each other so as not to be separable near that point. It passes on to the region of the back as two series of longitudinal cones, the outer large and powerful, the inner thin and slender. The outer has the bases of the cones directed forwards, while those of the inner are directed backwards. They are limited to the space between the articular processes and the articulation of the ribs with the transverse processes. The outer and inner series of cones are inserted into the whole length of the transverse processes posteriorly; towards the inner part the cones are fixed to the anterior articular processes, while, towards the outer, the cones are attached to the posterior margin of the ribs. Superficially they are connected by aponeurotic tendons to the inner surface of the horny skin-plates, and to the superficial tendons of the spinalis. The conical arrangement becomes elongated into long flat muscular bundles, which may be considered as the *Transversalis cervicis* which is attached to the articular processes of the cervical vertebræ as far as the arch of the atlas.

Trachelo-mastoideus, placed to the outer side of the last part of the longissimus-dorsi, arises from the transverse processes of the 2 or 3 upper dorsal and lower cervical vertebræ, passes between the transverse and articular processes of the cervical vertebræ, and is inserted into the posterior part of the mastoid process under the second splenius.

Spinalis is the inner part of the tail mass, and consequently placed to the inner side of the longissimus-dorsi. It may be considered as originating with the longissimus-dorsi at the end of the tail. It possesses the conical arrangement of the longissimus-dorsi, which is better marked at the upper half of the

tail, and is limited by the articular and spinous processes. It connects spinous process with spinous process, each muscular and tendinous bundle passing from one spinous process to another four or five distant. This arrangement of the spinalis extends along the whole tail up to the upper part of the back, where it seems to end. The tendons of insertion are aponeurotic in the lower part of the tail, but become strong, rounder, and considerably longer in the upper part of the tail and back. They bifurcate, as it were, before they become attached; one segment of the bifurcation passes upwards and inwards to the spinous process to which it is attached; the other segment passes upwards and outwards into the inner series of the longitudinal cones of the longissimus-dorsi. By this means the two muscles, or rather, the two parts of the mass of muscle, are intimately connected with each other; at the same time, this peculiar termination of the muscle completes the series of conical arrangements in the back and tail, which exist in such a marked degree in the whole muscular system.

Splenius capitis is in part the continuation of the spinalis to the head. It is the most powerful and most superficial muscle of the neck. It arises from the upper surfaces or tips of the 2 upper dorsal and all the cervical spinous processes by well-marked, round, muscular digitations or processes, which pass outwards and upwards, converging to form the general mass, which ends on a strong, round, short tendon, and is inserted into the occipital bone at its upper part near the middle line.

The next series of muscles to be noted lies somewhat under those last described. The direction of the longissimus-dorsi and spinalis is longitudinal throughout, and in the case of the longissimus the bundles pass from transverse process to transverse process, whilst the spinalis passes from spine to spine. But the series now to be described has an oblique course from the roots of the transverse and articular processes to the spinous processes; and the muscles are directed from within outwards, that is, obliquely from the deeper to the more superficial aspect of the body.

Semi-spinalis. Its tendinous and muscular bundles proceed from the lower cervical or the dorsal and lumbar roots of the

transverse and articular processes, to the spines of the dorsal, lumbar, sacral, and upper caudal vertebræ; they pass obliquely under the tendons of the spinalis downwards and inwards to their points of insertion, and are attached to the anterior margin of the spinous processes. Each muscular bundle extends from the articular and transverse process above to the fifth spinous process below. The semi-spinalis is continued up to the head by means of a muscle so like the splenius that it may be considered as a *splenius secundus*. It arises from all the cervical spinous processes under the splenius by nine muscular processes, which converge upwards and outwards to the back part of the skull, where they join a stronger and rounder tendon than that of the splenius, which is fixed to the back part of the head a little internal to the mastoid process.

Multifidus spinæ. Its muscular and tendinous bundles are quite distinct from the preceding. They lie deeper, nearer the spinous processes, are easily separable, and have a different direction. They constitute a mass, which is present in the tail and back, but stops short in the cervical region. I have not been able to ascertain their existence in the lower third of the tail, but in the upper two-thirds they appear very delicate, but gradually increase in size and strength as they proceed forward. They lie close against the spines, at the same time their course is obliquely upwards and inwards; their external surface is tendinous, the internal chiefly muscular. The fibres arise from the roots of the articular processes; from which they ascend obliquely upwards and are supplemented by delicate flat muscular processes, which take their origin from the spinous processes at the anterior margin, and are present in the whole length of the mass. The tendons of insertion thus constituted are fixed to the posterior margin of the spines, and each is generally attached to the seventh vertebra above the articular process from which it arises. As the semi-spinalis extends from above downwards from articular and transverse to spinous processes, whilst the multifidus goes from below upwards and inwards and not only joins spinous and articular processes together, but also one spinous process with another, the two muscles are essentially

distinct. The multifidus does not send any prolongation to the cranium.

Inter-spinales are thin plates of fleshy fibres placed in pairs between the spinous processes of the contiguous vertebræ. They exist in the neck, and are delicate in the dorsal and lumbar regions. They are much stronger and broader in the upper half of the tail, where they are well differentiated; but in the lower part of the tail they are not so easily recognized. They extend from the tip to the roots of the spinous processes.

Inter-articulares are small muscles placed between the articular processes in the lower part of the cervical, the whole of the dorsal and lumbar regions, and the upper part of the tail. They reach from the posterior articular process of one vertebra to the posterior articular process of the vertebra below.

Inter-transversales. In the cervical regions are placed small muscles between the transverse processes and the cervical ribs. They are in contact with the longus-colli, which becomes entwined with their fleshy bundles.

Subvertebral Muscles.

Recti capitis laterales interni are two small muscles placed, one on each side of the middle line, at the upper part of the neck. They arise from the inferior spines of the 2 upper vertebræ, and diverge to be inserted into the base of the skull round the foramen magnum.

Recti capitis laterales are much longer and larger than the preceding. They have double origins, an inner from the inferior spines, and an outer from the roots of the transverse processes of the 5 lower cervical vertebræ, which converge and are inserted together near the foramen magnum.

The *Longus colli* arises from the body of the fifth dorsal vertebra, the inferior spines of the upper 4 dorsal and the last cervical vertebræ, stretches obliquely forwards and outwards to be inserted tendinous and muscular into the cervical ribs, where it is entwined with the fleshy bundles of the inter-transversales.

Ventral Muscular Mass of the Tail.

Ischio-coccygeus, a powerful fusiform muscle situated ventrally on either side of the chevron bones, with its broad end

towards the ischial symphysis. It arises at the end of the tail from the bodies of the vertebræ and the sides of the chevron bones by two longitudinal bands of muscular and tendinous fibres, which pass forward for some distance, increasing in size, strength, and number, so that, after a short space three longitudinal bundles appear, which soon increase to four, then to five. For the lower fourth or so only of the muscle the longitudinal arrangement is clearly defined; but in its course the conical arrangement becomes more and more distinct, until about the middle of the muscle the cones assume their most characteristic appearance, which continues along the upper fourth or so of the tail, when the longitudinal direction and conical arrangement seem to pass into each other by gradations, which however are still indicated by the direction of the superficial aponeurotic fibres. Near the root of the tail the muscle splits into two distinct portions, which form an opening for the passage outwards of the muscle situated deeper. It ends in two portions, one, a powerful round tendon on the inferior surface of the ischium near the symphysis; the other a similar tendon, but flatter near the junction of the ischium and ilium. From the twelfth or thirteenth caudal vertebra up to the base of the tail the muscle has no attachment to the sides of the chevron bones, because the femoro-perineo-coccygean muscle occupies their whole aspect, except at the tip, to which the ischio-coccygeus continues to be attached. As the transverse processes do not extend down the whole of the caudal vertebræ, but end about the fifteenth, the muscle from the vertebræ below this point is attached to an aponeurotic membrane which, higher up, extends upwards and curves downwards on each side from the extremities of the caudal transverse processes, but lower down is continued along the bodies of the remaining caudal vertebræ to the end of the tail[1]. When the muscle is attached to the transverse processes, it is to their under surfaces by aponeurotic tendons, which do not extend so far inwards as the bases of the processes; for the femoro-perineo-coccygeus intervenes. The muscle is possessed of five rows of cones, arranged thus:

[1] Prof. Goodsir, *Edin. Philosoph. Journal*, Jan. 1857, p. 128.

the two marginal (that is, the row nearest the ventral middle line, and the row in contact with the transverse processes) and the central rows have their cones directed with the apices towards the head, whilst the intermediate rows have their cones arranged in a reverse direction. The bases of the cones end in a thin, strong, aponeurotic structure, which passes outwards to be attached to the several horny skin plates.

Femoro-perineo-coccygeus, placed under the preceding and concealed by it, except at its upper part, where it passes through the triangular space between the two portions of the ischio-coccygeus, arises by powerful flat muscular processes from the descending processes of the chevron bones, the under surfaces of the transverse processes of the 13 upper caudal vertebræ, and the mesial aponeurosis. Thin and pointed at its origin it becomes thicker and rounder as it passes obliquely upwards and outwards through the space on the outer wall behind the ischium. It ends on a thick round tendon which is inserted into the inner and upper aspect of the small trochanter of the thigh-bone, and sends an offset down to the back of the thigh to join the tendon of the gastrocnemius. Between the ischio-coccygeus and femoro-coccygeus is a layer of fat with the hæmal divisions of the spinal nerves and the aponeurotic membrane before referred to.

Pyriformis arises from the bodies of the 2 or 3 upper caudal vertebræ, and is inserted behind the tendon of the femoro-coccygeus into the small trochanter. Another muscle, which may be considered a *Pyriformis accessorius*, arises from the roots of the transverse processes of the last sacral and first caudal vertebræ. It passes round the femoro-coccygeus in a circular manner, to be inserted into the symphysis and hinder border of the ischium, receiving slips from the upper part of the ischio-coccygeus. At its middle it has a flat tendon about an inch broad, which is in contact with the femoro-coccygeus so as to form a pulley round which the muscle may act.

Muscles of the Inferior Half of the Trunk.

Pyramidalis, placed on the ventral aspect of the trunk, consists of two layers; the superficial, somewhat pyramidal,

stretches between the ischio-coccygeus and the superficial division of the external oblique muscle, and lying in the same plane with them, is attached to the upper part of the ischio-coccygeus, and passing upwards limits the cloaca laterally. It ends on the 3 or 4 abdominal ribs, crosses obliquely over the adductor muscles of the thigh, and covers the hindermost third of the external oblique. It sometimes sends a slip of fibres to the upper part of the cloaca. The deep layer, stronger and shorter, arises from the symphysis and the inner margin of the horizontal part of the ischium, extends upwards and slightly outwards to the upper margin of the pubis and the lower abdominal ribs, and covers the adductors and external obturator muscles, and the os pubis, and partly also the internal obturator.

Obliquus externus, like the pyramidalis, consists of two layers, which cover each other, each having a thoracic and an abdominal part. The superficial thinner layer arises by a broad aponeurotic tendon from the 10 or 11 lower ribs, and passes obliquely downwards and inwards to the middle line. The upper third or so ends at the outer margin of the thoracic sternum, and is covered by the hinder parts of the pectoralis major, while the abdominal part is blended with the deeper layer at the outer margin of the rectus abdominis. The deep layer arises by 8 or 10 digitations from the 10 lower ribs; the 4 upper interdigitating with those of the serratus magnus. Its fibres pass in the same direction as those of the superficial layer, both ending on the same tendon, which forms an aponeurosis covering the rectus.

Rectus abdominis arises broad from the pubis, and tapers towards its insertion into the 5 lower ribs and the ensiform cartilage of the sternum. Its continuity is interrupted by the 8 abdominal ribs.

Obliquus internus arises, in conjunction with the lower part of the transversalis, from the lumbar vertebræ and the anterior part of the iliac crest, and is inserted into the lower 3 or 4 thoracic ribs. It may be considered as the abdominal prolongation of the internal intercostal muscles.

Transversalis arises by a thin aponeurotic tendon from the

anterior part of the iliac crest, the transverse processes of the lumbar vertebræ, and the outer boundary of the lower part of the vertebral ribs. Its fibres pass forwards, constituting a thoracic and an abdominal part. The thoracic part lies under the sternum, while the abdominal part lies under the rectus.

Quadratus lumborum arises from the anterior part of the ilium in common with the ilio-costalis, from which it separates after a short distance to proceed to the last ribs and the transverse processes of the lumbar vertebræ.

Muscles connecting the Pelvic Region with the Posterior Extremity.

In describing the muscles of this region I have adopted the arrangement given by Stannius[1]; and as the muscular anatomy of the leg of the crocodile has been the subject of a special paper by the Rev. S. Haughton, M.D., I shall take the opportunity of pointing out some errors into which I think Dr Haughton has fallen[2].

Division of muscles according to Stannius:

Abductors—Glutei. Abductor femoris.

Rotators—Obturators. Iliacus.

Adductors—{ Quadratus femoris. Adductors, primus and secundus. Gemellus, Pyriformis, Femoro-coccygeus.

Extensors { outer Abductors—Tensor fasciæ. Glutei. middle Extensors—Vasti. Cruræus. inner Adductors—Rectus. Sartorius.

Flexors of the lower leg (Tibia and Fibula).

Flexor adductors of the Tibia—Gracilis. Semi-tendinosus.

Flexor adductor of the Fibula—Semi-membranosus.

Flexor abductor of the Fibula—Biceps.

Abductor femoris (psoas), from the sides of the bodies of the 5 lumbar vertebræ, and the under surfaces of their transverse processes, passes over the acetabulum to the upper fourth of the outer side of the femur.

[1] *Handbuch der Zootomie. Zweites buch der Amphibien*, p. 135.

[2] *Annals and Magazine of Natural History*, xvi. 3rd series, pp. 326—330.

Gluteus maximus, from the dorsal ridge and the anterior half of the ilium, and is inserted into the fascia of the thigh somewhat to the outer side of the knee-joint. It overlaps the tendon of the rectus in front of the knee-joint.

Gluteus medius, entirely covered by the preceding, arises by short tendinous fibres from the dorsum ilii for about its middle third. Its tendon passes over the great trochanter, and is inserted into the posterior aspect of the upper half of the thigh-bone.

Gluteus minimus, from the dorsum ilii below the medius, is inserted into the great trochanter at its upper part.

Obturator internus, from the internal or abdominal surface of the os pubis, and the posterior abdominal ribs, passes below the acetabulum to the inner side of the femur, and ends in conjunction with the tendons of the obturator externus and quadratus femoris.

Obturator externus, from the under or outer surface of the os pubis, and the membrane between the pubic bones, descends obliquely outwards over the hip-joint, to be inserted into the femur with the internal obturator and quadratus femoris.

Iliacus, from the inner surface of the ilium, ischium and acetabulum, passes out of the pelvis to be attached to the inner side of the upper fourth of the femur.

Dr Haughton has misconceived these rotator muscles. Thus his marsupial muscles are no other than the external and internal obturators, his marsupial bones are the pubic bones, and his pubic bones are the bones of the ischium. This want of recognition of the proper subdivisions of the pelvic bones has also led him into error in his description of the gluteus maximus and medius, rectus femoris, sartorius, gracilis, semi-tendinosus, semi-membranosus, and biceps.

Quadratus femoris from the middle of the ischium at its symphysis passes obliquely forwards and outwards to end with the obturator muscles.

Adductor primus, from the ischium further forwards than the preceding, is inserted along the middle third of the inner side of the femur.

Adductor secundus, a thinner muscle than the primus, from

the outer boundary of the ischium, is inserted into the femur behind the primus.

Gemellus, from the upper surface of the ischium, passes horizontally outwards, winds round the head of the femur, and is inserted into its upper and posterior part below the capsule of the hip-joint. The gemellus and pyriformis have not been identified by Dr Haughton.

Femoro-perineo-coccygeus. To this muscle Dr Haughton gives the name of *Extensor femoris caudalis*, which seems to me not very appropriate, as the muscle is a powerful adductor.

Tensor fasciæ femoris, from the spine of the ilium passes to be inserted into the middle of the fascia of the thigh. Dr Haughton has miscalled this muscle 'Gluteus minimus,' and seems altogether to have overlooked the proper gluteus minimus.

Rectus femoris, from the base of the pubis passes obliquely down the anterior part of the thigh over the outer side of the knee, under the tendons of the gluteus maximus and biceps, lying in a groove formed by the deep extensors of the thigh and leg. It emerges behind the lower part of the knee, then assumes another muscular belly like the external head of the soleus, and finally joins the gastrocnemius, which is inserted into the os calcis.

Sartorius, from the pubis a little above the rectus passes to the extensor side of the femur, and ends on the fascia below the tensor fasciæ.

Cruræus and *Vasti* require no special note.

Gracilis arises by a thin tendon from the anterior margin of the ischium, and by a smaller head from the tuber ischii; both pass down the inner side of the thigh to join the next muscle.

Semi-tendinosus, from the hindermost part of the ilium passes down the back of the thigh, joins the gracilis, and is inserted into the inner and upper border of the tibia.

Semi-membranosus is composed of three parts, an adducting belly from the hindmost boundary of the ischium, passes down the posterior part of the thigh to the back of the

upper end of the fibula, and two abducting bellies, one, small, arises from the hindmost part of the ilium in conjunction with the semi-tendinosus, passes down the back of the thigh and joins an arciform tendon common to the adducting belly; and the second abducting belly, which arises from the hindermost part of the ilium, between the heads of origin of the biceps and semi-tendinosus, passes down the back part of the thigh, more superficial than the adducting and abducting bellies just referred to, and ends on the arciform tendon at the upper part of the fibula. In the same manner that the femoro-coccygeus gives off its tendon at the upper part of the thigh to join the gastrocnemius, so does the common terminal tendon from these three bellies give off a long flat tendon, which passes down the back of the leg along its fibular side to the outer side of the tarsus. At its lower part it is joined by the tendon of the fibularis posticus, and the united tendons are fixed to the outer border of the tarsal bones.

Biceps, a double muscle, the two heads arise near each other from the hinder part of the ilium behind the gluteus maximus, they pass down the posterior and outer aspect of the thigh, one joins the flattened tendon of the gluteus maximus near the knee, the other splits into two tendons opposite the knee; one ends on the top of the fibula, the other ends on the peroneus longus muscle. One of the subdivisions of this muscle is named by Dr Haughton *Agitator caudæ;* but as it possesses no connection with the tail the name is evidently inappropriate.

ON THE SKELETON OF A RICKETY DWARF.

By Professor HUMPHRY. (Plate II.)

THE skeleton of a rickety female dwarf, lately placed in the Anatomical Museum of the University of Cambridge, presents sufficient features of interest to render it worthy of a brief description.

The ligaments are preserved, dried, and varnished, without having been very well cleaned. This obscures somewhat the ends of the bones but gives an assurance as to the correct position and relation of the several parts.

Of the history of the person I only learn that she is said to have been a well-known beggar in the streets of Paris about five-and-twenty years ago, and that she attained to the age of 85. It is clearly the skeleton of an aged person; for the alveolary processes of the maxillæ are completely removed as they are only in advanced life, the body of the lower jaw being reduced to a mere rim of bone, and the lower surface of the upper jaw being reduced to a level with the hard palate and the malar bones in a manner which is rarely seen even in senile skulls.

The rickety flexures are such as are commonly observed when the deformity dates from an early period of life. The tibia and fibula are bent sharply forward about the middle, the left fibula having the broad sabre-like form not unfrequently seen in these cases. The femur is bent forwards and outwards a little above the middle. The acetabula are pressed in towards the promontory of the sacrum which has descended a little towards them so as to give a somewhat triradiate form to the brim of the pelvis. The sacrum is sharply curved. The spine presents a flexure to the right in the dorsal region with flexures in the opposite direction above and below, that in the loins being more marked than that in the neck. There is the usual rotation of the bodies of the vertebræ towards the convexity of the several curves; that is to say, they are rotated towards the right in the back, which has the effect of throwing the angles of the ribs backwards on that side and forwards on the left, and

so gives an obliquity to the thorax and causes the left costal cartilages to present as the most anterior part of the chest. The natural curves of the clavicles are exaggerated, especially the outer curves. The radius and ulna are bent outwards and backwards a little above the middle. The humerus is bent a little outwards about the point of attachment of the deltoid, though less than is often seen under similar circumstances; and it is bent sharply outwards at the lower part, placing the internal condyle considerably higher than the outer, and giving great obliquity to the articular surface which, instead of the natural alternating elevations and depressions, presents a plane elongated convex (roller-like) surface upon which the surfaces of the radius and ulna are fitted to revolve. The rotation of the radius necessary for pronation and supination of the hand must have been limited.

The points, however, to which I would especially call attention are those indicated in the table of measurements. From this it will be seen that the height of the person was about 3 feet; and this low stature was not dependent upon the curvatures but upon the actual shortness, or deficient growth, in the bones. The skull has nearly the average size, and so have the bones of the face; but all the other bones fall considerably short of the natural dimensions. To the association of dwarfism with rickets, as well as to several of the other points illustrated by this specimen, I have already called attention in a paper on the influence of Rickets, &c. upon the growth of the bones, in the XLVth Vol. of the *Medico-Chirurgical Transactions.*

The deficiency of growth is by no means equally shared by different parts of the skeleton. It is most marked in the lower limbs, more marked in the femur and humerus than in any other parts of them, and more marked in the femur than in any other bone of the body. Indeed the femur has not attained to one half of its normal length, and is not longer than the tibia instead of exceeding it, as it should do, by three inches or more. This ratio of deficiency of length corresponds pretty closely with the measure of the growth of these parts in early life. During that period the lower limbs grow faster

than the upper; the humerus and femur grow faster than the other parts of the limbs; and the femur grows faster than any other bone. That the dwarfing effects of rickets—its impress upon growth—should thus be most evinced where most growth ought to take place, and that the fœtal or infantile type should be stamped upon these persons, is precisely what we should expect. In this, however, as I have shown elsewhere[1], there is a distinction between the rickety and the true dwarf; for in the latter the natural or adult proportions of the several parts are attained, and the grown person is fairly proportioned, though undersized. We may hence infer that the cause of stunted growth in those persons in whom a marked deficiency of stature is associated with want of proportion between the several parts and with an ordinary-sized or large head, is usually of the nature of rickets or allied to it.

Such persons are often very strong. There is a relatively large amount of cerebral or will-force acting upon the small limbs; and the prominent ridges on the bones, as well as their hardness, attest to the firmly implanted sinews and the powerful acting muscles. This, in the present example, and I have observed the same in others, is most marked in the upper limbs (especially in the humerus), which must, to some extent, have done the duty of the lower limbs as well as their own.

The shafts of the bones are rather small, which is rendered more apparent in consequence of the enlargement of the ends of the bones. This is caused chiefly by a bulging of the epiphysial or growing lines of the bones. The epiphysial lines, as is well known, are cartilaginous strata interposed between the epiphyses and the shafts for the purpose of permitting new bone to be added to the ends of the shafts; and the bones are in this way increased in length. The cartilage grows and ossification extends into it from the shaft. Now, in rickets the first of these processes—the growth of the cartilage—takes place, though not so freely as it should do, still, at a rate disproportionate to the calcifying or ossifying process. Hence the cartilage remains softer than natural, and yielding under the

[1] *Treatise on the Human Skeleton*, p. 101.

weight becomes squeezed out at the circumference of the bone, causing a flattening and widening of the end of the bone, and, subsequently, when ossification takes place, a more or less irregular projecting line at the junction of the epiphysis with the shaft, somewhat like the nodulated ring at the base of the stag's horn. This is most apparent at those epiphysial lines where the greatest amount of growth should take place, viz. at the lower end of the femur, at the upper end of the tibia, and at the upper end of the humerus[1].

I may observe that the facial and the cranial portions of the skull present a remarkable contrast. The former has undergone the ordinary changes consequent on loss of teeth, parts being removed and others thinned, so that it is far lighter than in adult life; whereas in the cranial portion the very reverse has taken place, the bones having become thicker, harder, and heavier. This is most marked in the calvarium, but is apparent also in the lower parts of the skull, including the roofs of the orbits. It is not to be confounded with the expansion and possible subsequent hardening of the bones occasionally observed in rickets, and leading sometimes to enormous thickening of the skull. It is, I believe, rather to be regarded as a senile change; at least I have met with it in several crania of aged persons[2]. The curious fact, that the cranial portion of the skull in advancing life not unfrequently increases in weight, while the facial and all the other parts of the skeleton are undergoing an opposite change, is perhaps partly to be attributed to the wasting of the brain, which takes place in old age, and to the consequent diminution of pressure in the interior of the skull, which may lead either to a thickening of the bones or to an increase of the subarachnoid fluid, or to both these. This, however, will scarcely explain the increased density as well as thickness.

The tenacity of life, under such unfavourable circumstances, witnessed in this case and in some other examples of a like kind, speaks well for the capabilities of the human body.

[1] See paper by me on the 'growth of the long bones,' *Medico-Chirurg. Trans.* XLIV.

[2] *Treatise on the Human Skeleton*, p. 195.

		Normal measurement.	Difference.
The height of the skeleton in its present position, *i. e.* from the dorsum of the instep to the top of the head	32·5		
The height of the skeleton from the sole round the convexities of the leg and thigh-bones	38	65	27
Circumference of skull round occipital and frontal protuberances...............	19	20·5	1·5
Spine from occiput to sacrum measured straight	14		
Spine from occiput to sacrum measured following curves	15·5	22	4·5
Clavicle	4·2	6	1·8
Scapula from upper to lower angle (vertical)	5	6·2	1·2
Humerus from summit of head to lowest point of external condyle	6·2	12·7	6·5
Humerus from summit of head to lowest point of internal condyle	5		
Radius	6·2	9·2	3
Hand	6	7·3	1·3
Pelvis, from top of ilium to bottom of tuber ischii	6	7·3	1·3
.... antero-post. diameter	3	4·3	1·3
.... transverse	3·7	5·2	1·5
.... greatest width of sacrum	3·2	4·7	1·5
Femur	7·5	17·8	10·3
Tibia	7·5	14·4	6·9
Foot	5	10·6	5·6

ON THE DOMESTIC CATS, FELIS DOMESTICUS, AND MUSTELA FOINA, OF ANCIENT AND MODERN TIMES. *By* PROFESSOR ROLLESTON, M.D. *Oxford.*

HAVING recently had occasion to study the habits and anatomy of the English Marten Cats, *Mustela Martes* and *Mustela Foina,* and having looked into the history of these animals and of certain other carnivora which have borne the same name as they in ancient and modern times, I have come to think that the latter of the two creatures specified, namely, the white-breasted Marten, *Mustela Foina,* was the animal which the ancient Greeks and Romans employed for the same domestic purposes for which we employ the *Felis Domesticus:* whilst this latter animal has been employed as at present in Western Europe for probably a considerably longer period than the last thousand years. Other writers to whom I have referred, and amongst them notably Dureau de la Malle, have adopted the former of these conclusions; but upon premises more or less inadequate or incorrect, or both. I am well assured that this question has for the philosophic naturalist much more than a merely archæological interest, for in the resolving of it we may have light cast upon the working of the principle which Mr Darwin has shewn to be more potent than any other in regulating the distribution of species, and which Van Beneden, with the well-known physiological[1] aphorisms of Wolff and Treviranus before his eyes, has formulated in the words[2], "les êtres qui composent une Faune sont solidaires entre eux comme les organes d'un être vivant." It is true that no such close interdependence as exists between man and certain other of the domesticated animals, even to the extent of the interchange of disease and death by the intermediation of cysti cerci and echinococci, has been shewn to obtain between him and any of the animals of which I shall here have to write; but readers of the "Origin of Species" will recollect that more intricate, if less

[1] Paget's *Surgical Pathology*, p. 17, ed. Prof. Turner. Lewes, *Physiology of Common Life*, I. p. 286. Wolff, *Theoria Generationis*, p. 108, § 236.

[2] *Recherches sur les Faune Littorale de Belgique. Cétacès*, p. 4.

mournful, networks, may bind up the presence in a particular country of a domestic animal with something so apparently distant from its sphere of operation as the general colouration of the landscape. Col. Newman[1] shewed how the number of humble bees in a district depended on the presence of man, whose domestic cats kept down the numbers of the honey-loving and devouring field-mice; and Mr Darwin demonstrated in the way of experiment, that the presence of the humble bee was a prerequisite for the fertilization of the heart's-ease and red clover. The dependence of animal life upon the presence of particular forms of vegetable life is familiar enough to us; our own comfort depends too directly in these over-peopled days and countries upon the adequate abundance of our flocks and herds, and that adequate abundance again depends too directly upon that of the turnip crops, unknown to our forefathers, to suffer us to forget it; but it is none the less true that the peculiar character of the vegetation, and consequently of the landscape of a country, depends very frequently upon the peculiar characters of its animal inhabitants. The antelopes[2], by carrying and dispersing the seeds of grasses, change the characters of the African Desert; and the red glow of the clover field which gratifies the eyes of the artisan depends ultimately on pollen-carrying insects, and at second hand from them upon the cats which spend their daylight hours in the same murky atmosphere that he does. It is possible that some such secret bond may exist between the widely spread family of the *Mustelidæ*[3], and that of the *Abietineæ*, the geographical range of which so nearly coincides with theirs. In this country the geographical distribution of the firs is now all but exclusively dependent upon man's artificial aid; where it does take place independently of him, it takes place in great measure by the aid of the squirrel which carries off the cones or seeds, and, having buried them, forgets, or is unable to dig them up again. It is not likely that any direct alliance subsists between any musteline and any rodent, but the more arboreal and egg-loving muste-

[1] *Origin of Species*, p. 84, 4th Ed.

[2] Livingstone's *Travels and Researches in South Africa*, 1857, p. 99.

[3] A. Wagner, *Abhand. Akad. Wiss. München.* Bd. IV. p. 26 and 107, 1846.

lines such as the martens, may by robbing the nests of the rapacious birds such as the carrion crows, the great enemies of the squirrels, indirectly but most efficiently favour the spread of these latter creatures. But the subject of the interdependence of the two kingdoms of animal and vegetable life is a much larger one than the one I propose to deal with here; and I have but introduced the mention of it to shew what broad and distant views may be gained by attentive gazing through what may seem to be but narrow casements. I shall arrange what I have to say under two heads. I shall first attempt to prove that though the ancient Greeks and Romans had not domesticated the cat, *Felis Domesticus*, in classical times, this animal was nevertheless domesticated in Western Europe at an earlier period than is commonly assigned. And secondly, I shall address myself to shewing that the white-breasted Marten, *Mustela Foina*, which is known also as the "Beech Marten" or "Stone Marten," was functionally the "Cat" of the ancients. A list of the different works and memoirs which I have consulted or read upon the topics I have written upon will be found appended to this article. Either my conclusions or my premises, or both, will be found by any one who will verify the references I have given to differ more or less from those of most or all the writers I have quoted, in all or most of the points which we treat of in common; but I have abstained from the invidious task of specifying in detail the various errors small and great into which I think my predecessors, great and small, have, Sir G. C. Lewis not excepted, fallen.

A few words may be employed at the outset in elucidating one of the [1]few universally or all but universally conceded points in this history, and shewing that the classical writers knew nothing of any domesticated Felis in their own countries, and that Mr George Scharf[2] has consequently fallen into an anachronism in introducing a figure of our cat into his vignette in illustration of the telling of Lord Macaulay's tale of the

[1] Link, *Die Urwelt und das Alterthum*, pp. 199—201, Berlin, 1821. Klemm, *Culturgeschichte*, I. 1, quoting Link. Isidore Geoffroy St Hilaire, *Hist. Nat. Gen.* Tom. III. 96.

[2] *Lays of Ancient Rome*, p. 78, 1860.

Battle of the Regillus. In Egypt the cat was domesticated from an early period, as we know from Herodotus and also from the book of Baruch[1]; and Cuvier[2] could not discover any specific difference between the mummied remains of the domesticated Felis of those days and the similar structures in our own tame cats. Varro (fl. B.C. 28), and Columella (fl. A. D. 20), both speak of the *Felis* as Oppian (fl. A. D. 190) does of the *αἴλουροι κακοεργοί* as animals to be kept out of poultry-pens, but none of these writers speak of the animal as being domesticated; and Cicero when he speaks, or hints, *more suo*, that he would speak but for a reluctance to be tedious, *de felium utilitate*, speaks in the same connexion of the ichneumon and the crocodile, and shews us thereby that he had Egypt and not Italy in his eye. The two lines in the Batrachomyomachia, 51—52,

πλεῖστον δὴ γαλέην περιδείδια ἥτις ἀρίστη
ἣ καὶ τρωγλοδύοντα κατὰ τρώγλην ἐρεείνει,

do not seem to compel us to translate *γαλέην* by *felem*, as *κατὰ τρώγλην* may very well mean "*along and throughout* my hole," and indeed the line

ἐχθίστη γαλέη τρώγλης ἔκτοσθεν ἑλοῦσα

may seem to shew that the catching *outside* was a rare occurrence, and the inside or musteline method the commoner[3].

Neither do I think that certain others of my predecessors have been more correct in translating the words in the fifteenth Idyll of Theocritus, the Adoniazusæ, line 28,

αἱ γαλέαι μαλακῶς χρήσδοντι καθεύδεν,

[1] *Epistle of Jeremy*, *Book of Baruch* (Apocrypha), chap. vi. verse 22.

[2] *Annales du Muséum*, An. XI. (1802), p. 234. *Ossemens Fossiles. Discours Préliminaire*, pp. lxii—lxiii. ed. 1821.

[3] It must be recollected however that though a carnivore's body will always pass tolerably easily through a foramen which will allow of the passage of its head, the *μῦες* of the Batrachomyomachia were not *rats*, Parliamentary institutions not having been introduced into the kingdom of Artemisia, where and when it is supposed to have been composed, and that as the thirty-first of Babrius' Fables, or indeed measurement with a pair of compasses of even our smallest weasel's interzygomatic diameter, will shew, many a mouse-hole will admit a *mouse* which will not let his enemy in after him. But the *γαλῆ* was essentially troglodytic, though some holes were too small for it, else my argument would fall to the ground, and Sannyrion would not have written

τί ἂν γενόμενος εἰς ὀπὴν ἐνδύσομαι;
φέρ' εἰ γενοίμην γαλῆ;

as though the domestic cat was alluded to by Praxinoe. For though our proverb speaks of the catching of a weasel asleep as a matter of some difficulty, anybody who has watched the way in which one of the larger mustelines when tame or at least in captivity composes itself to sleep, and the very evident reluctance with which it unrolls itself, when awaked, out of the dog-like convolution into which it has curled itself up, will feel the force of the more correct rendering. Some of the Alexandrians, again, who were contemporary with Theocritus, used the same word for the tame cats, with which they were more familiar than he, a mere occasional visitor in Egypt, could have been, that Herodotus uses. Callimachus, in his *Hymn to Ceres*, has, line 111,

καὶ τὸν αἴλουρον τὸν ἔτρεμε θηρία μικκά,

where the Scholiast *in loco* gives κάττος as the synonym.

On the other hand the compiler of the collection of foolish stories (which is ascribed falsely to Aristotle, and called the "De Mirabilibus Auscultationibus"), who is supposed to have lived about the same time as Callimachus and Theocritus, speaks, as does Ælian after him, *N. A.* 15. 26, section 28, of a kind of Cyrenian mouse as being πλατυπρόσωπος ὥσπερ αἱ γαλαῖ; and it is difficult to think that γαλαῖ is not intended to stand in this passage for *Feles*. Section 28 however may have been introduced into this treatise, in later times, or possibly the words ὥσπερ αἱ γαλαῖ may by themselves have found their way there as a gloss from the pen of some wise Byzantine to whom in a later age, when the γαλῆ of the classic times had resigned both office and name to the αἴλουρος from Egypt, *curæ fuit ejusmodi quisquilias conscribere.* The Batrachomyomachia, it should be observed, is quite free from any taint of Alexandrian or Byzantine impurity, and the use of the word γαλῆ by writers from these localities does not bear therefore upon its employment in the verses above quoted from it. But though there is no reason for supposing that the *Felis domesticus* was domesticated in any other country than Egypt before the Christian era, there are many reasons for demurring to the statement ordinarily[1] made

[1] For example, *Conversations Lexicon*, Bd. VIII. p. 735. Bahr, Hdt. II. 66.

to the effect that this animal was first spread throughout Europe at the end of the period of the Crusades.

On looking into Ducange's Glossarium, under the words "Catta," and "Cattinæ Pelles," I find that Cæsarius, who was the physician-brother of Gregory, the Theologian of Nazianzus, and who died A.D. 369, having been the friend of the second Constantine and Constantius, speaks of ἔνδρυμοι κάτται; and I presume that the use of this expression shews with some degree of probability that tame cats were in use by this time in Constantinople. The date of Palladius is somewhat uncertain, though supposed with a good deal of probability to have been about the same as that of Cæsarius, but as his local habitation appears to have been Italy, his words, IV. 9. 4, "Contra talpas prodest catos frequenter habere in mediis carduetis, mustelas habent plerique mansuetas," are of importance. They shew that the two kinds of cat were both in use as domesticated animals side by side and at the same time, in Italy, nine hundred years before the first of the Crusaders reached Constantinople, and in the days of Gratian and Theodosius, not in those of Godfrey and Tancred. From the same authority, Ducange, I find that Evagrius (fl. 536) many years later, indeed almost a couple of centuries after the date ordinarily assigned to Palladius, still recognizes αἴλουρος as the more correct denomination for the Felis domesticus, saying, as though the word κάττα were a somewhat trivial and over-familiar designation, αἴλουρον ἣν κάτταν ἡ συνήθεια λέγει, lib. VI. 24. The word "bird" stood once, I believe, in much the same relation to the word "fowl;" and the householders of this country shew often a greater precision and correctness, more *prisca fides* in short, in this matter of the use of these two words than the Upper Ten Thousand do.

I have had a reference given me to a work of the period of Eustathius, i. e. about 1100 A. D. viz. the Γαλεωμυομαχία of Theodorus Prodromus, in which the word γαλῆ may be found[1] and proved to be used for the cat as we understand the word. I have not however been able to discover or borrow

[1] The following are a few lines from this work, taken from an edition printed at Basle, 1518, by Frobenius, without numbering to the lines. They are, I think, conclusive:

any reference to the employment of the word γαλῆ in the sense of Felis or in any other in the writings of any author who flourished, if authors did flourish, in the six hundred years which rolled so drearily away between the days of Evagrius and those of the author of this tragi-comedy. The word *mustela* seems, I may say in leaving this part of my subject, nearly always if not quite, to stand for a weasel of one kind or another; though Phædrus does once, namely IV. 1. 9, use the word in a passage homologous with one of those in which we find *αἴλουρος* used in the fables ascribed to Æsop. This latter word, on the other hand, seems always to stand for a Felis domesticus or catus; whilst *Felis* in the Latin writers does seem, according to Facciolati, to be used indifferently, or nearly so, for either Feline or Musteline.

The argument to shew that our white-breasted Marten, *Mustela Foina*, was used for the same domestic purposes by the ancients as the Felis domesticus is by ourselves, may be briefly stated thus. An animal called γαλῆ by Aristotle (*Hist. Anim.* II. 3. 5, VI. 30. 2, VIII. 27. 2, IX. 2. 9, ib. 7. 4), and repeatedly referred to by Aristophanes[1] and other Greek writers of the

A. τίς ἐστιν αὕτη; μὴ φθονήσῃς τοῦ λέγειν.
B. ἣν γαλέην ὠνόμαζεν ἀνθρώπων γένος,
αὕτη γὰρ αἰεὶ χηραμὸν περιβλέπει
καὶ μῦς ἐρευνᾷ.
ἡμᾶς διϋχνεῖ λυγκικὸν βλέπουσά τι.
πολλὴν καταγνοὺς τῶν πάλαι πεφυκότων
τὴν ἀσθένειαν καὶ κακίστην δουλείαν
ἀνθ' ὧν περ' εἴσω φωλεῶν μυχαιτάτων
μένοντες οὐκ ἄτολμον εἶχον καρδίαν.
καὶ δὴ κατεῖχε τοῖς ὄνυξιν ἀγρίως
καὶ σὺν τάχει βέβρωκε τὸν νεανίαν.

[1] Aristophanes, *Acharn.* 255: κἀκποιήσεται γαλᾶς
σοῦ μηδὲν ἧττον βδεῖν.
Plutus, 693: ὑπὸ τοῦ δέους βδέουσα δριμύτερον γαλῆς.
Vesp. 363, 4: ὥσπερ με γαλῆν κρέα κλέψασαν
τηροῦσιν ἔχοντ' ὀβελίσκους.
1182: οὕτω ποτ' ἦν μῦς καὶ γαλῆ.
1186: μῦς καὶ γαλᾶς μέλλεις λέγειν ἐν ἀνδράσιν.
Thesmoph. 558: ὥς τ' αὖ τὰ κρέ' ἐξ 'Απατουρίων ταῖς μαστροποῖς διδοῦσαι
ἔπειτα τὴν γαλῆν φαμέν.
Eccles. 792: ἢ διᾴξειεν γαλῆ.

best ages, as well as by the Scholiasts[1], under this title and in more or less completely proverbial expressions, is spoken of as destroying mice, snakes, lizards, birds and birds' eggs, as being the reverse of odoriferous, as being addicted to stealing, and also being so common an animal as to be, like our cats, a convenient scapegoat for the blame due to the thefts of other and not quadrupedal animals, and finally, as being like in its colour and its pelage, except that this latter is a little less thick, and its general appearance and its moral characteristics to the animal called in antithesis to it *γαλῆ ἀγρία*, but ordinarily *ἴκτις*, which is a little larger, which loves honey, which kills birds, and is very susceptible of being tamed. It is impossible to think that any great mistake can attach to the interpretation of statements so consentient, so numerous, and relating so eminently to matters of every-day life and constantly observable occurrence. We have two sets of resemblances and differences detailed to us as existing between two animals, the *γαλῆ* and the *γαλῆ ἀγρία* or *ἴκτις*; these two sets of resemblances and differences are just those which exist between our white-breasted marten and our yellow-breasted marten, and as I believe it is impossible to find a second pair of animals to which this comparison will apply, I apprehend that the point is proved. Both the British martens are, as I know from my own observations, and information gathered from persons in the habit of hunting them, great destroyers of mice, birds, and snakes; they are both stated in the ordinary works of natural history to be fond of honey, which the ferret[2] and the weasel will not touch; the fur of both is valuable, but that of the larger species is the more valuable.

Simonides of Amorgos, fl. B.C. 660. Stobæus, *Florilegia*, Vol. III. ed. Gaisford, p. 63, T. 73. 61:

κλέπτουσα δ' ἔρδει πολλὰ γείτονας κακὰ
ἄθυτα δ' ἱερα πολλάκις κατεσθίει.

Cf. also *γαλῆ χιτώνιον*, *γαλῆ κροκωτόν*. Babrius 27, *γαλῆ θηρῶσα μῦς τε καὶ σαύρας*. Mr Max Müller tells me that in the *Hitopadesa* an animal, called *Nakula*, kills the serpent under the same provocation, and with the same reward as the hound kills the wolf in our story of Llewellyn. It very probably may have been a marten.

[1] Cited by Schneider from Eustathius and elsewhere in his edition of Aristotle's *Hist. An.* IV. p. 48, 49, q. v.

[2] Buffon, VII. 213. Wagner, *Saugethiere*, I. 500.

The colouration of the Polecat, *Mustela Putorius*, puts it out of the field into which it has so often been wrongfully introduced, as does also the not altogether[1] unimportant fact that it is not certain that it is found in the extreme south of Europe. If any one who has not had, or perhaps does not care to have, proof that the common north-country name for the marten, viz. "Sweet Mart" as opposed to "Foumart" or "Foul Mart," an *alias* which the polecat has earned, may not after all be so distinctive as to make us think that we cannot have in the white-breasted marten the same creature as that alluded to in the first two passages I have quoted from Aristophanes, wishes to have this scruple removed at easy cost, he may consult Gesner (*Hist. Anim.* p. 866), who quotes something, *in loco*, to the purpose, from Alexander Aphrodisiensis. The stoat, *Mustela Herminea*, could not have failed to have had the well-marked club-shaped black tip of its much larger tail mentioned in contradistinction to that of the common Weasel, *Mustela Vulgaris*, if these two animals had been the pair contrasted as γαλῆ and ἴκτις; and it may further be remarked that the comparatively small bulk of these animals, as also of the Sardinian Weasel, *Mustela Boccamela*, which has also had its claims advocated for the title of γαλῆ, would have very sufficiently prevented them from being the "fine thieves" which we know from Simonides, Aristophanes, and Babrius, the γαλαῖ were. In looking over my notes of the anatomy of the last marten, a male, which came into my hands, I find that there was upon its *linea alba* a space of two inches in length almost bare of hair to direct attention to the fact mentioned by Aristotle, *Hist. An.* II. 3. 5, *καὶ γάρ ἡ γαλῆ ὀστοῦν ἔχει τὸ αἰδοῖον*, and to explain how he came to class this comparatively small animal as regards this carnivorous peculiarity with animals so much larger as the fox and the wolf.

I will conclude the question of the Marten Cat with the lines from Nicander, the contemporary of Theocritus, which Schneider gives, *l.c.* IV. p. 49, and I will add to them, what Schneider does not *in extenso*, viz. the commentary of the Scholiast as given in the Editio Princeps of Aldus Manutius,

[1] Blasius, *Saugethiere Deutschlands*, p. 224.

printed 1499, before the art of printing was sixty years old. I give the lines and the Scholium, as both are much to the points just discussed and dismissed, and neither are hackneyed in the literature of the subject. Nicander, *Theriac.* l. 196:

> *Μορφὴ δ' ἰχνεύταο κινωπέτου οἷον ἀμυδρῆς*
> *ἴκτιδος ἥ τ' ὄρνισι κατοικιδίῃσιν ὄλεθρον*
> *μαίεται, ἐξ ὕπνοιο καθαρπάξασα πετεύρων.*

To these lines are laterally apposed in the cramped contractions of the edition specified, the following words of the Scholiast[1]: *ἀμυδρῆς δε ἤτοι μικρᾶς ἢ τῆς δεινῆς καὶ ὀργίλου. ἴκτις δὲ ἡ λεγομένη ἀγρία γαλῆ. καὶ Ὅμηρος κρατὶ δ' ἐπικτιδέην ὡς ἀπὸ τῆς ἴκτιδος τοῦ ζώου.*

Thirdly: Strabo's words, III. 386, quoted by Schneider, l. c. III. p. 524, and relating to the taking of rabbits, *καὶ δὴ καὶ γαλᾶς ἀγρίας ἃς ἡ Λιβύη τρέφει, φέρουσιν ἐπίτηδες, ἃς φιμώσαντες παριᾶσιν εἰς τὰς ὀπάς. αἱ δ' ἐξέλκουσιν ἔξω τοῖς ὄνυξιν,* prove, I suppose, beyond a question, that *γαλῆ* stood for Ferret, *Mustela Furo,* as well for the Martens, as early as the Christian era.

Fourthly: As one kind of *γαλῆ* was known as the *Ταρτησσία γαλῆ,* and as the Scholiasts tell us[2] *Ταρτησσίαν* was used *ἀντὶ τοῦ μεγάλην,* and as Herodotus informs us, IV. 192, that *γαλαῖ* very like these Tartessian (or larger) *γαλαῖ,* were to be seen in Libya, where we know any animal like and larger than a marten would be a viverra, I think we may with some little probability suppose that the *Ταρτησσία γαλῆ* was nothing less or else

[1] I hope I shall not be considered presumptuous for saying that having seen the Pine Marten or Yellow-breasted Marten escape "like a shadow," as Longfellow describes the hare as doing, from the midst of an assemblage of men and dogs of all dimensions when smoked out from under some rocks, I believe I have a better idea of what Nicander, who may have been similarly privileged, meant by *ἀμυδρῆς* than the Scholiast had. Good as was the creature's need, its agility was more than commensurate with it; and whilst the words *abiit, excessit, evasit,* and, alas, for the interests of anatomical investigation, *effugit* also, are but weak symbols to express its speed, it takes a whole hexameter-ful of imagery to give the picturesque effect which its lithe abstraction of itself from jaws and paws produced upon me. It fled

Par levibus ventis volucrique simillima somno.

[2] See Aristoph. *Ranæ*, ed. Bothe, adnot. ad l. 440, sub voce. *Ταρτησσία μύραινα,* ibique citata.

than the Viverra Genetta, which is found all over Africa and also in the South of Spain and France, where it is domesticated even now, here and there, and acts as a tolerable cat. I have not been able to find that this animal is known in Greece, it is not included by Blasius in his *Saugethiere Mittel-Europas;* whence we can the better understand why it was called Ταρτησσία γαλῆ; though it is found in Asia Minor, whither it may have found[1] its way by way of Egypt. If the Herpestes Widdringtoni, recently[2] found in the Sierra Morena, had been as well known in the region of Tartessus as the Viverra Genetta, its claims to be considered as the Ταρτησσία γαλῆ would perhaps have been as much greater as its size is. But the Pharaoh's Rat, which would then have been the γαλῆ of Herodotus as being the representative of the Spanish Herpestes, would have been contrasted with it in the point of being considerably smaller, which however is not the case. I append measurements of these and of certain other of the animals of which I have spoken in this paper, the point of size being the point in which the Tartèssian or Spanish Marten is contrasted with the commoner one by the Scholiast, and being, as it seems to me, sufficiently great to mark the difference which the lateral and the caudal striping of the Genet also constitutes between it and the γαλαῖ of Greece.

	Lgth. body.	Lgth. tail.
Common Genet, *Viverra Genetta*	20″	16″
Pharaoh's Rat, *Herpestes Ichneumon*	18″	18″
Spanish Ichneumon, *Herpestes Widdringtoni*	22″	20″
White-breasted Marten, *Mustela Foina*	16″	8″
Yellow-breasted Marten, *Mustela Martes*	18″	12″
Polecat and Ferret, *Mustelæ Putorius et Furo*	18″	6″
Sardinian Weasel, *Mustela Boccamela*	8½″	4″
Stoat, *Mustela Erminea*	10″	4″
Common Weasel, *Mustela Vulgaris*	7½″	2″

The upshot of this paper then is to shew that in classical times the word γαλῆ was used by the Greeks to denote the

[1] Ainsworth cit. A. Wagner, *Munich Abhand. Akad. Wiss.* IV. 107.

[2] Gray, *Ann. and Mag. Nat. Hist.* 1842, IX. 50.

Musteline Martes and Ferret, but not the Polecat probably, though probably the Genet; and that in later times, but not till later times, it was used also for the *Felis Domesticus*. The word *mustela* does not seem to have been transferred together with the office when the latter was handed over from the Marten to the Felis, in Italy. In the East the Felis took both the name and the work of the rival it supplanted. It did succeed in supplanting the Marten as the domestic mouse-killer, probably partly by virtue of its greater attachment to man and to place, partly by virtue of its less pronounced tendency to burglary and petty larceny, partly by virtue of its more even temper, and partly by its greater cleanliness and less offensiveness. The very points, also, in which as a wild animal it is inferior, make it superior as a domestic one to a musteline. Its constitution being less plastic it cannot fit itself as easily as they can to varying climates, and in many, as Rengger has shewn of Paraguay, it cannot run wild. Its range of foods is more limited, and its faculty for, and its courage in adopting new methods of purveying for itself, less conspicuous than theirs. Hence "the poor cat of the adage" being more dependent on man, has been obliged to render itself more useful to him than the Marten, and it has very successfully turned its inferiority to "commodity."

The question as to how, in the trivial language of two different nations, English and Greek, in modern as in ancient times, Viverrines[1], Mustelines, and Felines, have each had a representative called by the same name as a couple of animals, one in each of the two other families, is a little harder to understand for the anatomist or for the anatomical artist, than it is for anybody who, being devoid of either of these accomplishments, will stand inside the half-shed half-house for the "Small Carnivora" at the Zoological Gardens, and listen there to the remarks of people who overlook the little differences upon which scientific zoology is founded. "They are all cats," I heard one of these authorities[2] say there one

[1] We speak of a Civet *Cat* as well as of a Marten *Cat* and common *Cat*.

[2] Strabo, however, uses much the same language in speaking of what must, I think, in all probability have been the common Genet, *Viverra Genetta*. Writing

day, albeit there were there then plenty of the eminently annuloid Viverrines as well as a very typical Felis, the *Felis Chaus*, to be compared and contrasted at a single glance and within a few feet of each other. It is not hard to see how the Mustelines and Viverrines come to be classed together, seeing that so many members of both families are so markedly elongate, vermiform, tapering, and low on their limbs. But the relative proportions in the sides in the trapezium which four lines, corresponding one to the forelegs, one to the hind, one to the line of the back and the fourth to the ground on which the creature stands, make up respectively in a Feline and in a Viverrine or Musteline viewed from the side are so very different, to say nothing of the all but equally striking differences in the proportions of the skull and jaw diameters, longitudinal and transverse, *inter se*, firstly, and in relation to the cervical region, secondly, that we must look to points of habit rather than of structural arrangement to account for the imposition of this common name upon creatures to our eyes so different. And I suppose the springy, yet silent lightness of their step when placid, and the lightning-like pounce of their attacking step, correlated as they are with a more or less similar armature in tooth and claw, are the points which "imaginationem ferientia aut intellectum vulgarium notionum nodis astringentia," have caused the imposition of the common name these animals have had given them. The arboreal and nocturnal habits again, correlated with certain modifications in the organs of special sense, are common points to the Feles and the Mustelæ, and especially though not exclusively the martens. Both alike take to trees when pressed by hounds, but since the invention of firearms this single device of the "cats" is no longer worth as in the old fable more than all the tricks of the Fox. The phrase "up a tree," was not, perhaps could not have been anterior to that of "as sure as a gun." The Pine Marten indeed will, Blasius informs us, sit still on the same place

of Mauritania he says, XVII. c. 3, p. 827 A, Casaubon, *φέρει δὲ καὶ γαλᾶς αἰλούροις ἴσας καὶ ὁμοίας, πλὴν ὅτι τὰ ῥύγχη προπέπτωκε μᾶλλον.*

on a bough after having been shot at once and missed. The cat has, Rengger informs us (*Saugethiere Paraguay,* p. 214), learnt to kill the rattle-snake in Paraguay, and I have read that the Felis acquired this selfsame snake-killing dexterity in the island of Naxos, but I have not the reference at hand at this moment. Herein it has by practice under the stimulus of constant provocation come to resemble the Mustelines in what is instinctive to them; but though it will steal cream, as Falstaff told us, it will never, like the martens, steal eggs nor honey nor take to burrows in the way of refuge.

I am aware that there are both scholars and men of science to whom disquisitions such as these will seem but the *strenua inertia hominis male feriati.* Critics such as Pope, and, I regret to have to add, such as Hallam (see *Literature of Modern Europe,* I. 277), speak of such attempts to preserve the unities of time and place in Faunæ as in dramas, the one with the cynical sneering giggle, the other with the elevated and refrigerating yet half-compassionate contempt congenial to their respective schools of literature and of politics. But to the scholar I would say that, though in these matters as in many others by increasing knowledge we increase also sorrow, or at least our susceptibility for annoyance, it is rare indeed to find a writer of the classical periods making the blunders in the way of putting animals into places which they never were found in except in connexion with the circus of olden or the menagerie of modern times, which are so rife in all but our very best modern writers. Modern catalogues of African Mammals shew that Virgil did not deserve the criticism as to the presence of the stag there which Pope in the *Martinus Scriblerus* puts into the mouth of Bentley as unworthy of any one else; and that Lipsius need not have explained away, as he does (*Elect.* II. 4), the phrase *Libystidos ursæ.* The placing of the Lion in Sicily by Theocritus, I. 72,

τῆνον χὠ 'κ δρυμοῖο λέων ἀνέκλαυσε θανόντα,

is, in fact, the only anachronism or anatopism of the kind which my memory furnishes me with from the writers of the best periods of Greek and Roman literature.

To the man of science I may say in the words of Göthe:

"Müsset im Naturbebrachten
Immer eins wie alles achten
Nichts ist drinnen, nichte ist draussen:
Denn was innen, das ist aussen
So ergreifet ohne Säumniss
Heilig öffentlich Geheimniss."

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ON A NEW METHOD OF INCREASING THE PRESSURE ON THE ARTERY IN THE USE OF THE SPHYGMOGRAPH.

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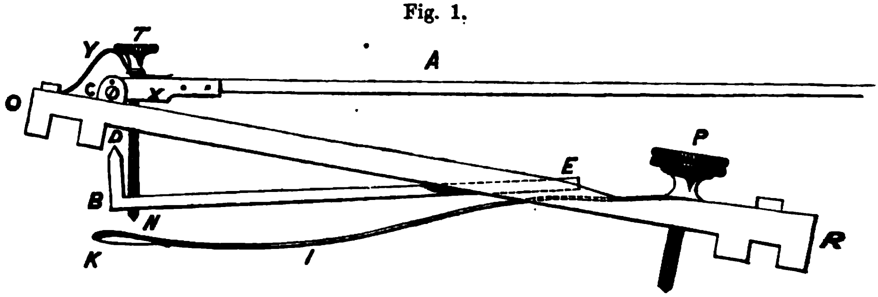
THE Sphygmograph in the hands of Wolff and others has yielded pulse traces much more complete in their details than those originally published by Marey. This satisfactory result has been obtained by attention to some minor points in the application of the instrument; which, as often happens, the followers of the inventor have had the good fortune to discover. In the present state of Sphygmography there is urgent need, that the mode of applying the instrument, and increasing the pressure on the vessel, should be clearly understood in order that reliable results may be obtained by the less experienced observers. In a brief note published in the *Medico-Chirurgical Review* for July last, I pointed out how we may measure the amount of pressure exercised on the artery by the descent of the tactile spring. In this communication I propose to suggest a second method by which pressure may be applied more readily and estimated more accurately. A brief reference to the plans adopted by Wolff and others will, however, most profitably precede the description of the arrangement to be proposed in this paper. The woodcut (fig. 1)[1], which shews the principal parts of Marey's sphygmograph, will aid the reader to understand these plans and to follow my remarks.

Fig. 1.



[1] For a full description of this figure see the author's little work *On the use of the Sphygmograph in the investigation of Disease*, pp. 10, 11.

In his excellent and laborious treatise (*Charakteristik des Arterienpulses*), Wolff tells us that he found the position of the writing lever AA' as regulated by the screw T, had considerable influence in developing the finer features of the pulse trace. When he turned the screw more than was necessary to bring the knife-edge D of the prop (DB) into contact with the lever at X, he discovered that he not only raised the writing point of the lever, but also exercised greater pressure on the artery. The traces collected with the lever writing high up exhibiting features which were greatly obscured, or altogether lost when the lever was low down. In the instrument used by Wolff, however, the little spring Y was much stronger than it is made in the instruments now sold; and it was found when the lever was very much elevated, that the spring Y in Wolff's sphygmograph, was strong enough to completely destroy the value of the trace. In fact, the friction developed between the knife-edge D and the under-surface of the lever at X, was sufficient to interfere with the free communication of the movement to the lever. The spring Y was therefore removed, and Wolff found that he could obtain his results without its assistance, as sufficient pressure was exerted by screwing down T so as to elevate the lever. For my own part I must confess that the elevation of the lever has not succeeded in any experiments until the influence of the little spring Y has begun to make itself felt. The springs now used are however so very delicate that they cannot develope nearly so much friction as the stronger spring used by Wolff. The pressure to be obtained by this application of the little spring in many cases is not nearly sufficient to develope the secondary waves in the pulse trace, and when the lever is raised very high every one can notice, even when the spring T is removed, that the friction at the point of the communication of the movement from D to X is much too great to allow of exact registration.

Dr Anstie, in his able report on Medicine in the *Biennial Retrospect* of the Sydenham Society, mentions in reference to this subject, another plan that Dr Sanderson and Dr Beigel have used with advantage. It consists in hanging a little weight on the writing lever A, which according to its position on the lever exercises through the knife-edge D varying

degrees of pressure on the artery[1]. Pressure can certainly be thus obtained, and the amount may be estimated with great nicety, but my experience of it is not satisfactory, and moreover it is open to the same strong objection urged against the first-mentioned plan. The friction between the points D and X is greatly increased, and a very small amount of weight on the lever suffices to suppress all the finer features of the pulse trace. In order therefore for any plan to be free from the objections just mentioned, the weight must act *directly* upon the tactile spring at its point of contact with the artery. The weight when thus placed compels the spring to follow closely each movement of the vessel, and does not allow a severance of the connection at any moment during the period of expansion, or, when it is more likely to occur, at the beginning of the period of collapse. In the screw T we have the only means of exerting this *direct* pressure, not indeed by using it as Wolff did, who obtained indirect pressure through the action of the lever on D, but by acting directly on the screw T itself, and therefore by its point N on the tactile spring immediately over the artery. With this end in view, I have had a series of small weights made to fit the head of the screw T, so that by changing them, or placing several on at a time, the weight can easily be adjusted to the requirements of each case. The pressure falls *directly* upon the tactile spring immediately over the artery, and no extra friction is produced at X. On the contrary, the tendency is in the opposite direction, and the value of the little spring Y in maintaining a close connection between D and the under-surface of the lever becomes very evident.

All who have worked with the sphygmograph will at once admit that the amount of pressure required varies very much in different cases and under different conditions. The weight which developes clearly all the secondary waves in a full-sized pulse of moderate tension, for example, oftentimes suffices to suppress the true form of a smaller pulse, or the same pulse under conditions of feeble tension. Indeed, in cases where the tension is very low the feeling spring has often to be weakened before a true record can be obtained, as Wolff and Anstie have pointed out. The weights which have proved most useful in

[1] A similar plan has been adopted in Baker's new sphygmograph.

my hands vary in size from 6 to 12 grammes, and are so made that any number can be applied at one time, each weight fitting on the one below. A weight of 30 grammes, or even more, can be thus used. Occasionally small weights of 2 to 4 grammes will be found useful.

In the pulse traces figured below (figs. 2, 3, 4) we can see at a glance, how the small secondary waves, and even the great diastolic wave, become more clearly defined under carefully adjusted pressure.

In the first two pulsations (fig. 2) we have the form registered on the simple application of the instrument. The first secondary wave (a), and the great diastolic wave (b), and the notches preceding these waves are moderately well seen.

Fig. 2.

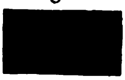
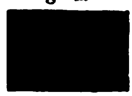


Fig. 3.

Fig. 4.



In the next tracing (fig. 3) we see these important features still better developed, and we remark the greater height of the line of ascent. In this case the pressure on the artery was produced by a weight of 16 grammes. In fig. 4, under a pressure of 26 grammes, the main features of the pulse trace have grown still more distinct, and gradually dawning on us, as it were, we see rising out of the great diastolic notch the second secondary wave c). Wolff has published similar forms obtained by his plan, but in cases where much pressure is required to develope all the features of a pulsation, no amount of lever elevation has sufficed in my experience to produce perfect traces. The use of the screw P for increasing the pressure on the artery should only be resorted to when very great pressure is needed, or when the artery is so deeply placed that the instrument as ordinarily applied cannot reach it. In the great majority of observations the amount of pressure available by the use of the weights recommended above will be found sufficient. The ease and rapidity of application, and the accuracy with which the pressure can be calculated, form the great advantages of the arrangement I have proposed; and as it necessitates no alteration in the instrument, and does not interfere with the elasticity of the spring, I trust others will soon confirm my opinion of its usefulness.

A CONTRIBUTION TO THE ANATOMY OF THE PILOT WHALE (*Globiocephalus Svineval*, Lacépede). By PROFESSOR TURNER.

IN the spring of the present year a shoal of Pilot Whales entered the Firth of Forth,—one of these, a young female, about 8 feet long, I obtained for the Anatomical Museum of the University, and as the anatomy of the soft parts of this cetacean has not received much attention, I have drawn up a brief account of some of the most interesting facts observed in the course of the dissection.

ARCH OF AORTA AND GREAT ARTERIES.—The arrangement of the aortic arch and great vessels proceeding from it in the cetacea has been chiefly studied in Delphinus phocæna, in which animal two innominate arteries are found arising from the transverse part of the arch. But whilst Cuvier and Meckel state that each innominate artery divides into a carotid, subclavian, and vertebral branch, Stannius has pointed out[1] that the common carotid trunk is completely wanting and that the internal and external carotids arise directly from the innominate artery. This description of Stannius has been confirmed by Barkow, Rathke and myself[2].

In the pilot whale the aorta *A* arched to the left, and at the place of junction with the ductus arteriosus *D* suddenly diminished in size. The right and left coronary arteries arose from its sides close to its origin. From the transverse part of the arch two large innominate arteries proceeded. The right ascended for about an inch and then divided into two branches. The anterior, somewhat the larger, gave off: *a.* carotis cerebralis, which ran forwards without branching as far as the basis cranii, where it passed through the carotid canal into the cranial cavity. *b.* carotis facialis, which ran forwards to supply the tongue, face &c. and for the most part represents in its distribution the external carotid artery. *c.* art. subclavia, which arched outwards to the anterior limb and gave origin to a small

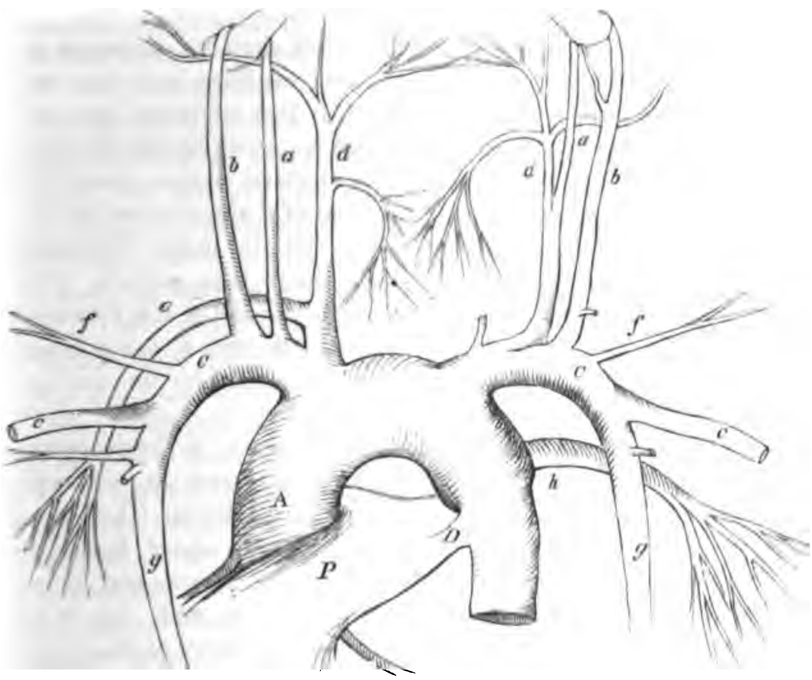
[1] Müller's *Archiv.* 1841, p. 379.

[2] *British and Foreign Medico-Chirurgical Review*, October 1862, p. 479.

transversalis colli *f*, and a large internal mammary branch *g*, the last-named being indeed of greater calibre than the continuation of the subclavian which passed to the anterior limb.

The posterior branch of the innominate artery after a course of $\frac{3}{4}$ inch divided into two branches: *d.* cervico-occipitalis passed forwards deeply in the neck parallel to the windpipe, gave off small branches to form a network between the bodies of the cervical vertebræ and the pharynx, and then turned outwards on the inferior aspect of the scalene muscle to the posterior

Fig. 1.



The arch and great arteries of the Pilot Whale. *A*, aorta. *P*, pulmonary artery. *D*, ductus arteriosus. *a*, carotis cerebralis: the diminution in calibre of this artery in the course of its ascent is not sufficiently represented in the figure. *b*, carotis facialis. *c*, subclavia. *d*, cervico-occipitalis. *e*, thoracica posterior dextra. *f*, transversalis colli. *g*, mammaria interna. *h*, thoracica posterior sinistra. For the drawing of this and the succeeding figures I am indebted to Dr J. W. Moir.

part of the cranium. *e.* art. thoracica posterior dextra passed behind the right pleural membrane to break up into branches for the large thoracic rete. In the porpoise, according to Stannius, the right innominate artery does not subdivide into two branches but gives off each vessel independently in the following order, right posterior thoracic, cerebral carotid, facial carotid, occipito-cervical and subclavian. In a specimen which I dissected not only did these vessels spring from the right innominate, but, between the origins of the facial carotid and occipito-cervical, a branch arose, which passed inwards behind the pharynx, to assist a corresponding vessel from the opposite side, in the formation of the large prevertebral cervical rete.

The left innominate artery gave off close to its origin a small branch to the thyroid gland and windpipe, and then ascended for about half an inch, when it also bifurcated into an anterior and posterior branch. The anterior branch divided into *b* the carotis facialis and *c* the subclavia sinistra, from the latter of which arose the transversalis colli *f*, and internal mammary *g*, arteries before it entered the anterior limb. The posterior branch ascended for somewhat more than an inch, and then divided into *a* the carotis cerebralis and *d* the cervico-occipitalis. The art. thoracica posterior sinistra *h*, arose from the back of the arch just before it was joined by the ductus arteriosus.

Stannius describes the left innominate artery in the porpoise as giving origin to the following separate branches, cerebral carotid, facial carotid, occipito-cervical and subclavian. The place of origin of the left posterior thoracic artery is not however constant in the porpoise. In Stannius' description, and in a specimen which I dissected, it arose from the arch, but in a second specimen (153), in the Anatomical Museum of the University of Edinburgh, it proceeded from the descending thoracic aorta nearly ½ inch below the ductus arteriosus.

The distribution of the posterior thoracic rete on each side in the pilot whale was most extensive, and the intercostal arteries participated very largely in its formation. The retia on opposite sides freely communicated across the middle line, and with a rich arterial network within the spinal canal, to

which they sent numerous offshoots through the intervertebral foramina. As the more minute arrangement of the great thoracic rete in the cetacea, first discovered by Tyson, has been so carefully described by Hunter, Breschet and Von Baer, I need not further refer to it.

The cerebral or internal carotid arteries appeared to be the only arteries of supply for the brain, and it is important to note that as they ascended to the skull they underwent a very considerable diminution in calibre, without giving off any branches in the neck. Dr Sharpey[1] and Von Baer[2] have also directed attention to the great diminution in size of the internal carotid arteries in the porpoise before they enter the cranium. This is a fact of very considerable interest, as bearing on the question of the rapidity with which nutritive changes may take place in the very important organ to which these vessels convey a supply of blood. In this young pilot whale the brain was of large size, and weighed, after having been immersed for some weeks in spirits of wine, 58 oz., which is several ounces greater than the average weight of the adult human brain; but as the amount of blood, which its arteries of supply could transmit to it, is very much less than the quantity transmitted to the human brain through its vessels, it may fairly be assumed that the functional activity of the brain in the cetacean is very considerably slower, notwithstanding its greater size, than that of the brain of man. Hence, in comparing brains with each other, it is not sufficient to consider merely, the differences in their absolute weight, or in their weight, as compared with the weight of the body, but their relative vascularity should be determined.

Each cerebral carotid artery, after it had entered the cranial cavity, gave off branches, which passed not only forwards and outwards to the lobes of the cerebrum and the tentorial aspect of the cerebellum, but backwards to the occipital surface of the cerebellum, the pons and the medulla. One posterior branch ran inwards to the middle line, where it joined a corresponding branch from the opposite artery to form a median vessel, which

[1] *Reports of British Association*, 1834, p. 683.
[2] *Nova acta Phys. Med.* Vol. XVII. 1835.

extended backwards as far as the commencement of the spinal cord and gave off in its course branches to the occipital surface of the cerebellum.

Both the foramen ovale and ductus arteriosus were closed. In comparing the branches which arose from the two innominate arteries it will be seen that the arrangement was far from being symmetrical on the two sides, for not only had the posterior thoracic arteries very different origins, but whilst on the right side the cerebral and facial carotids and occipito-cervical arteries arose independently, so that no vestige of a common carotid existed, on the left the cerebral carotid and cervico-occipital arose by a common trunk, which may perhaps be regarded as in part representing the left common carotid artery.

THE PANCREAS, covered with peritoneum on its inferior surface, was situated in the anterior curvature of the stomach almost parallel to the 5th compartment, and lay therefore across the abdominal cavity. It was upwards of 6 inches long by 2½ inches at its broadest part. It was succulent, and its lobules were, owing to the small amount of interlobular connective tissue, more closely aggregated together than is seen, for example, in the human pancreas. There was no gall-bladder, but entering the substance of the pancreas, close to its right extremity, were two wide and distinct bile ducts, which almost immediately joined to form a common tube, which, after a course of half an inch, was joined, whilst still enclosed by the lobules of the gland, by a large, strong-walled, pancreatic duct.

STOMACH. The stomach in the cetacea is a complex organ, and is subdivided into several compartments, the number and size of which is by no means uniform in the different genera. In the genus Hyperoodon seven compartments have been described, whilst in other genera, three, four, or five are said to exist. Anatomists, however, not unfrequently differ in their statements of the number of subdivisions of the stomach even in the same animal, the difference arising from the circumstance that a part, which some consider to be a distinct, though perhaps small compartment, is by others regarded only as a channel, or tubular passage, connecting larger subdivisions of the organ.

The stomach of the common porpoise has been most frequently examined, and it may assist in making clear the construction of the organ in the pilot whale, if I compare it with the stomach of the porpoise, two specimens of which I have at the same time studied, but in making the comparison, it should be kept in mind that the stomach of the porpoise was from an older animal than that of the pilot whale.

In this young pilot whale the 1st compartment (1) was 6 inches long, somewhat ovoid in form and opened into the bottom of the esophagus by an aperture, which admitted only two fingers, and which was neither so large nor so direct as the corresponding opening in the stomach of the porpoise. Its mucous membrane had the same general appearance as that of the esophagus, and was covered by a thick, laminated, squamous epithelium, but the membrane was not so rugose as in the corresponding compartment in the porpoise. From the character of its epithelium this compartment might indeed rather be regarded as an esophageal pouch than as a true digestive chamber.

The 2nd compartment (2) formed a large globular bag. It communicated directly by an aperture, which readily admitted four fingers, with the lower end of the esophagus, and which indeed, in this young specimen, was more direct than that of the 1st compartment with that tube[1]. Its mucous membrane presented however a very different appearance from that of the first, for large folds, laterally connected, wound spirally round the interior of the bag, and on the free surface of the membrane the mouths of numerous glands were visible. The line of separation between the esophageal and gastric mucous membrane was sharply marked by a circular fold, covered with thick esophageal epithelium, which surrounded the orifice of the 2nd compartment. In its general form, and the appearance of its mucous membrane, it closely resembled the corresponding com-

[1] After this description was written, I had the opportunity, through the courtesy of Dr Murie, of seeing a much larger stomach, from an older specimen of this species of whale, in which the relative size of the openings into the first and second compartments was reversed, that into the first being larger than the opening into the second.

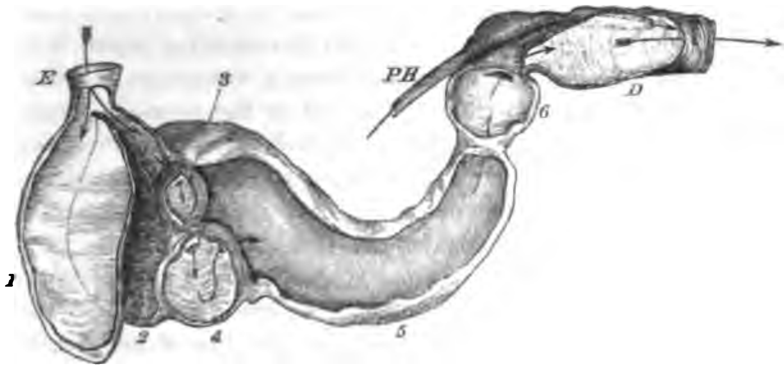
partment in the porpoise, but in the latter the opening was not into the esophagus, but into the 1st compartment, and luxuriant folds of the mucous membrane projected around the orifice.

Anatomists are in the habit, when comparing the complex ruminant stomach with that of the cetacean, of pointing out that in the former, two, if not three, compartments, communicate directly with the bottom of the esophagus, so as to permit of the passage of the food directly from the esophagus into one or other of the subdivisions of the stomach; whilst in the cetacean all the food must pass into the first compartment before it can be transmitted into the second. This statement, though undoubtedly correct as regards the porpoise and many other cetacea, could not be applied to the stomach of this pilot whale, in which the esophagus, when the eye was directed down the tube, could be seen freely to communicate at its lower end both with the 1st and 2nd compartments; so that a provision would seem to exist in this animal for permitting a process of rumination as far as regards the contents of these two compartments, and an additional link is established between the ruminant and cetacean stomach.

The aperture of communication between the 2nd and 3rd compartments was situated at the upper part of the intervening septum, and was only $\frac{1}{4}$ inch in diameter. The 3rd compartment (3) was the smallest of all the subdivisions of the organ, and, from its size, form, and position, evidently corresponded to the 3rd stomach of the porpoise. Before being opened into, it seemed to be only a tubular passage, or channel of communication, between the 2nd and 4th compartments; but, when the wall was cut through, a distinctly dilated sac-like cavity, of the size and shape of a large walnut, was recognised. The mucous membrane had the same colour as that of the 2nd compartment, and presented a few faintly marked folds and gland orifices. At its lower part the 3rd compartment communicated by an orifice, $\frac{3}{8}$ths inch in diameter, with the 4th subdivision of the stomach.

The 4th compartment (4) reached the lower border of the stomach. It was globular in form and as big as a medium-sized orange. Its muscular coat was much thinner than that of

Fig. 2.



Dissected stomach of young pilot whale arranged to show the communications between the compartments. *E*, esophagus. 1 to 5 inclusive, the five subdivisions of the stomach. 6, the dilatation immediately preceding the cylindrical duodenum. *D*, duodenum. *PH*, the conjoined pancreatico-hepatic duct.

the 1st and 2nd compartments, and its mucous membrane was almost smooth, but showed the mouths of numerous glands. No corresponding compartment is differentiated in the stomach of the porpoise[1]. It communicated with the 5th compartment by an opening somewhat smaller than the aperture of inlet.

The 5th compartment (5), homologous with the 4th or sigmoid stomach of the porpoise, was about 10 inches long, curved in its direction, and approached the cylindrical in form. It lay across the abdomen, and its left extremity extended beyond the 3rd and 4th compartments, so as to come into relation with the 2nd, where it formed a somewhat dilated cul-de-sac. Its muscular coat was comparatively thin; its mucous membrane was smooth, and numerous gland orifices were seen on its surface. It was evidently an important digestive chamber. A thick septum, pierced by an orifice in the centre, large enough to admit a quill, was situated at its right extremity. It resembled the septum at the intestinal end of the 4th compart-

[1] If the part of the left end of the sigmoid stomach of the porpoise, which forms a cul-de-sac below the opening into the 3rd compartment, were cut off from the rest of the sigmoid stomach by a septum, having an orifice in its centre, it would represent the 4th compartment of the pilot whale.

ment of the porpoise's stomach, and had the appearance of a pyloric valve. Through this orifice the 5th compartment communicated with a dilatation (6), as to the nature of which it is not easy to decide. In its general form it was not unlike that dilated portion of the alimentary canal in the porpoise, which John Hunter described as a 5th stomach, but which Professor Owen, on account of the conjoined biliary and pancreatic ducts opening into it, has more correctly regarded as the dilated commencement of the duodenum in that animal. In the pilot whale, however, the hepatico-pancreatic duct did not open into the dilatation, but on the summit of a papilla situated in the cylindrical tube of the duodenum. At the line of junction of this dilatation with the cylindrical part of the gut the canal was bent at a very decided angle, and a fold of mucous membrane projected for some distance across, so as materially to diminish the size of the passage. The mucous lining of this dilatation was almost smooth. Attempts have occasionally been made to show that the number of subdivisions of the stomach is uniform in the various genera of the cetacea. Meckel (*Vergleich Anat.* Vol. IV. p. 525) is of opinion that only three subdivisions exist, whilst the author of the article Cetacea in the *Cyclopædia of Anatomy and Physiology* considers it probable that five is the typical number of compartments. From the comparison which I have instituted between the stomachs of the porpoise and pilot whale, I do not think we are in a position to lay down any such general proposition; for, leaving out of consideration the dilatation marked 6 in the drawing, fig. 2, as to the nature of which there is room for a difference of opinion, we find that there are five distinct compartments in the stomach of globio-cephalus, whilst only four can be recognized in the porpoise, the compartment, marked 4 in the former, not being differentiated in the stomach of the latter.

In the cylindrical duodenum the valvulæ conniventes, somewhat faintly marked at first, gradually increased in size and number, and 2¾ inches beyond the projecting fold of mucous membrane, which marked the commencement of this part of the gut, the conjoined pancreatico-hepatic duct opened by a single orifice at the summit of a papilla. This duct after

leaving the pancreas joined the wall of the dilatation beyond the 5th stomach, and became so closely blended with it, that they were invested by the same serous membrane. It acquired also a very powerful muscular coat, and continued in intimate connection with the duodenum, its position being marked by a slight ridge on the surface, and then passed very obliquely through the duodenal wall to open on the summit of the papilla already described.

KIDNEY.—Each kidney was 7 inches long and, as in the porpoise, was subdivided into a large number of small pyramidal lobes, to the apex of each of which the lobular branches of the renal vessels and the calyx were attached. The calyces from the different lobules united to form an elongated tubular ureter, which, without dilating into a pelvis, left the kidney close to its posterior end. The renal vessels, on the other hand, lying close together, entered the kidney near its anterior extremity. The cortical substance of each lobe was very vascular, and contained numerous Malpighian tufts and convoluted uriniferous tubules. The pyramidal substance was almost non-vascular, and in the injected kidney its white appearance presented a striking contrast to the red cortex. It was not possible to inject the tubuli uriniferi from the ureter, the elongated form of the papilla on which they open and the small size of their orifices interfering with the admission of the injection.

THE BLADDER was almost cylindrical in form and remarkably small for so large an animal. It ended in a funnel-shaped urethra, which lay for 4 inches in close contact with the inferior wall of the vagina. The ureters opened into the bladder, close to the urethral orifice, and from their position, as well as the small size of the bladder, it is probable that but a small quantity of urine could collect in that organ prior to its excretion.

THE VAGINA, 6 inches long, was comparatively smooth internally close to its orifice, but its mucous membrane gradually became rugose, and at its deeper end was thrown into strong transverse folds, between which a quantity of thick mucus was collected. The cervix uteri, 1 inch long, opened by a

narrow orifice, the lips of which were liable to be confounded with the upper transverse mucous fold of the vagina. Into the summit of the cervix the mouths of the two uterine cornua opened.

THE THYROID GLAND.—As considerable difference of opinion existed amongst anatomists regarding the presence of a thyroid gland in the cetacea, I undertook some years ago an inquiry into the subject, and examined and described the gland in the Porpoise (*Trans. Roy. Soc.* Edinb. 1860). In the pilot whale also this gland was found situated on the inferior aspect of the cricoid cartilage, and extending forwards and upwards towards the sides of the thyroid cartilage. The lymphatic glands of the neck, more especially on the left side, were well developed.

SPLEEN.—Only 4½ inches long, consisted of one principal mass, with five more or less perfectly separated lobes, which varied in size from a fig to a kidney-bean.

LACTEAL VESSELS AND MESENTERIC GLANDS.—When the abdominal cavity was opened, and the intestines spread out, the lacteal vessels, distended with chyle, could be seen traversing the mesentery from its intestinal towards its vertebral border, some lying along with, others between, the branches of the mesenteric artery and vein. By the union of two, three, or more of the smaller lacteals larger vessels were formed, which sparingly anastomosed with each other through lateral communications. At the root of the mesentery many lymphatic glands were situated, one of which, especially large, was 2¾ inches long. To these glands the lacteals converged in large numbers, and though many entered their interior, yet a very considerable number ramified *on the outer surface of the glands*, and covered them so closely that the gland substance was almost entirely concealed. It is quite possible that the lacteals which invested one gland might, in their onward course, enter the interior of another somewhat nearer the spine. When the glands were bisected the surface of section presented a creamy aspect, doubtless from the quantity of chyle which they contained. In the *Philosophical Transactions for* 1796 Mr Abernethy de-

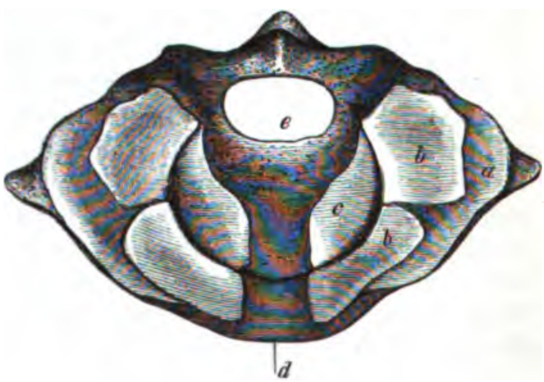
scribes, in a male balæna, the lymphatic glands as hollowed out internally into bags, with which a number of the lacteal vessels communicated; but the glands of the pilot whale presented no cavities in their interior, and, even after a stream of water had been directed on the surface of the section for some minutes, so as to wash away the chyle, the only openings which could be seen were the mouths of divided vessels. An injecting pipe was passed by my assistant Mr Stirling into several of the larger lacteals proceeding to one of the glands, and a carmine and gelatine injection forced along it, many of the lacteals on the surface of the gland were filled, and a portion also passed into its interior. On section patches of red injection were seen, which at first sight might have been regarded as lying in cavities; but careful examination showed that the appearance was due to extravasation of the coloured injection amidst the textures of the gland. The bag-like cavities, described by Mr Abernethy, may have been and probably were artificially produced in his preparations by the breaking down of the gland structure in the act of injecting. The death of this animal, at a time when absorption was actively going on, and the lacteals filled with chyle, has enabled me to show, even more conclusively than was done by Dr Knox in his experiments[1], that in the cetacea, as in other mammals, the chyle is conveyed to the blood by a special system of vessels, which in their course become connected with the glands situated at the root of the mesentery. The intestinal mucous membrane presented numerous transverse valvulæ conniventes. Its free surface to the naked eye seemed perfectly smooth, as if destitute of villi. When an inverted portion of the gut was held up to the light, and examined by a simple lens, a slightly flocculent appearance was recognised; and when these flocculi were looked at with higher powers they were found to be elongated narrow processes, connected by their bases with the narrow bands of mucous membrane which separated the circular, or oval, mouths of the large Lieberkühnian glands from each other. These processes were by no means scattered over the whole surface of the membrane, and the duodenal portion seemed to be without them. This

[1] *Edinburgh Medical and Surgical Journal*, p. 28. 1824.

part of the gut indeed, with the numerous, closely-set mouths of its Lieberkühnian glands, resembled in its appearance much more the mucous membrane of the large intestine in an ordinary mammal, than that of the small. From their comparatively scanty numbers, their irregular distribution, and attenuated aspect, these processes did not seem to be structures of primary importance; and evidently played but a small part, if any, in the absorption of the chyle. A rich net-work of fine chyle-filled lacteals could be readily seen immediately beneath the free surface of the membrane. In connection with the distribution of the lymphatic glands it may be noted that a large cluster lay close to the lower end of the rectum.

Cervical Vertebræ.—It was possible in this young animal to trace the order of ossification of the stunted cervical vertebræ with each other. The ventral part of the ring of the atlas was blended with the corresponding portion of the 2nd vertebra, and sent backwards a median process below the bodies of the 3rd and 4th vertebræ. The lateral portions and transverse processes of these bones were separated by cartilage, and the tips of the transverse processes were still cartilaginous. Owing

Fig. 8.



a, *b*, *b*, condylo-articular surface of atlas, the part *a* is yet cartilaginous. *c*, condylo-articular surface of axis. *d*, non-articular part of atlas. *e*, non-articular part of axis.

to the shallowness of the anterior articular surface of the atlas, the anterior surface of the body of the axis was in part also encrusted with articular cartilage, came into relation with the occipital condyles, and assisted in the formation of the cranio-vertebral joint. In and immediately on each side of the middle line the anterior surface of the atlas was non-articular, was continuous by ossific union with a similar non-articular portion of the axis, and corresponded to the interval between the occipital condyles. The bodies of the 3rd, 4th, and 5th vertebræ were ossified with each other and with the 2nd, but it was possible to see in a longitudinal section through the bodies, by a difference in the texture of the bone, where the original line of demarcation between the bodies had been, and a narrow ring of unossified fibro-cartilage marked externally the position of the inter-articular disk. The bodies of the 6th and 7th vertebræ had complete fibro-cartilaginous disks between each other and the vertebræ above and below. The spines and laminæ of the 1st and 2nd were blended with the left but not with the right lamina of the 3rd vertebra. The spines of the 4th, 5th, and 6th vertebræ were ossified into one mass, but the 7th was free in its entire extent. The transverse processes had no foramina at their roots.

The description of the Brain will form the subject of a future communication.

ON THE MORPHOLOGY OF THE ARTHROPODA.

By ANTON DOHRN, Dr Phil. *Jena.*

Read before the British Association, September 5th, 1867.

THESE investigations on the Morphology of the Arthropoda were made some weeks ago at Millport, on the Firth of Clyde.

It is well known to zoologists, that the first who worked out the development of the crustacea was the late celebrated Rathke, who gave an account of the embryology of Astacus fluviatilis. At that time also Von Baer propounded the history of development of the vertebrate animals: and as it was the endeavour of that period to find out the connexion and the relations between the vertebrate and the invertebrate kingdoms, both were working out the analogies and homologies of the arthropodous and the vertebrate embryology.

These principles were objected to by Professor Weismann at Freiburg. He stated, in his excellent work on the "Development of the Diptera," that the types of development in the insects—and therefore probably in the whole arthropodous class—and in the vertebrata were as different as possible, that there were no homologies at all to be found, and that the endeavours of Zaddach in his "Development of the Phryganidæ" to work out the theories of Von Baer and Rathke were fruitless and wrong. It was he who stated at first the presence of, what he called a *faltenblatt,* a membrane of the embryo, which appears before any other process after the formation of the primitive streak (*keimstreif*). It is necessary for my purpose, that I should give an account of the manner in which this membrane, called faltenblatt, is formed. The keimstreif surrounds the vitellus. At both ends of it a thin layer of cells begins to grow out, which finally encloses the whole embryo, or rather the keimstreif, by a membrane, in which structure is hardly to be seen, because it is so close to the primitive streak that only the outlines of the margins can be distinguished. The beginning of the formation of this membrane is at the back of the embryo; on the opposite side the membrane soon splits, and the extremities grow out.

In the most remarkable book, "Für Darwin," the well-known zoologist in South Brazil, Fritz Müller, made a brilliant application of Darwinian principles to the embryology of the crustacea; and stated that the *Nauplius*, the so-called larva of copepoda and cirripedia, was also the first larval state of a decapodous crustacean, of a *Peneus;* that this *Peneus-Nauplius* then changed into a *Zoëa*, the *Zoëa* into something like a *Mysis*, and that after these stages it becomes a *Peneus*. He was of the opinion that all crustacea were the offspring of nauplius, and I think he proved it or at least made it very probable.

For the embryology of the edriophthalmous crustacea he stated, that there was a third membrane, besides the chorion and the inner egg-skin, surrounding the body and being fastened on the back to the vitellus. He called this membrane "larval-membrane," and expressed the opinion, that it was wrong to call the heap of cells, which connect, in all amphipoda and in some isopoda, the larval-membrane with the back of the embryo, micropyle-apparatus, as it was called by Professor Meissner and La Valette de St George. This larval-membrane he identified with the nauplius, and considered it to be the last remains of the earliest state of the edriophthalma.

Last year I published a paper on the embryology of *Asellus aquaticus*[1], in which I described the larval-membrane and, like Müller, declared it to be the *nauplius-membrane*. I did not find, perhaps I overlooked, the so-called micropyle-apparatus, but I found two organs or appendages developed before all other organs on the sides of the embryo, the so-called trefoil-like processes (*blattförmigen anhaenge*) of Rathke. I don't consider those appendages to have any function, but, like the larval-membrane and the micropyle-apparatus, to be the remains of the lost earlier stages of their genealogical development.

The structure of both the micropyle-apparatus and the trefoil-like processes was uniform—long outgrowing cells surrounding cavities, and giving origin to cuticular membranes.

In the same year I examined the embryology of the Phryganidæ, and discovered at the same time with Professor Weis-

[1] *Zeitschrift f. wissenschaft. Zoologie*, Bd. xvii. Heft. 2.

mann and the Russian zoologist Elias Mecznikow, a third membrane round the embryo, consisting of large distinct cells. The membrane was connected with the back of the embryo and, splitting as soon as the embryo, grew and became too large for the space within the membrane. I published a little paper on the subject in the *Medizinisches Centralblatt* of Berlin, and indicated that this membrane in the Phryganidæ and the larval-membrane in Asellus might be true homologous formations. I had the pleasure of finding that Professor Weismann in a letter to me expressed the same opinion.

In opposition to this view Mecznikow in his elaborate work "Embryologische Studien an Insecten" contended, that there was no homology at all between the membranes in insect and in crustacean embryos. He rather preferred to advocate the old opinions of Zaddach, Rathke, and Von Baer, of the supposed homologies between arthropoda and vertebrata, and not only compared the third embryonic membrane in insects with the amnion of vertebrata, but named it Amnion Insectorum.

As a means to elucidate still further the subject, I undertook further investigations, and compared the embryology of almost all genera and species of edriophthalma I could get in the Baltic at Kiel, and in the St George's Channel at Millport I studied the development of Palæmon, Crangon, Lithodes, Portunus, and at last added most special researches on Mysis and Cuma.

I am happy to say, that Cuma has furnished me with the material, which seems to justify me in bringing out a new theory on the morphology and the homologies in the whole class of Arthropoda. Though in this brief communication I cannot enter into all the arguments which might be advanced in support of my theory, I hope shortly to publish a more extensive account of my investigations.

The most remarkable fact in the anatomy of Cuma is the manner in which the respiratory apparatus is shaped. There is in the cavity between the body and the carapace a large and complicated instrument, called by my predecessors branchia; it is described, though not quite correctly, in Henry Goodsir's paper[1] on the matter. But it is not a branchia in the true sense,

[1] *Edinb. New Phil. Journal*, January, 1843.

and is only used to excite a current of water, which enters behind and goes out near the top of the head in a most striking way. The whole apparatus is fastened to the third maxilla and moved by its movements up and down. If it is elevated, twenty laminæ on the upper side push out the water through the long channel to the top of the head; the orifice there being formed by a most remarkable little joint connected with the whole instrument. If it is depressed the laminæ give way to the water and the little joint shuts the orifice, so that no water could go out behind, or come in in the opposite direction.

The blood goes out of the heart by an aorta and by two large blood-vessels on the sides. After several bifurcations, and the giving off to the abdomen of a great vessel, these blood-vessels enter the carapace, which is constructed of two walls, connected one with the other by a great number of little links, which are the hardened processes of the cells of both walls. Round the margin there is a broad channel opening into the pericardial sinus. The blood-vessels bifurcate many times before they lose their walls and allow the blood to pass into the space between the two walls of the carapace. Here the blood-corpuscles interchange the carbonic-acid with the oxygen, enter afterwards the marginal channel, and are brought back by the pumping movement of the heart to the pericardial sinus.

The complex form of respiratory apparatus just described in Cuma is to be regarded as a high degree of elaboration of the simple and fundamental form met with in Zoëa.

But as Cuma has in all parts a great affinity with the isopoda, as is proved by the embryology, which I have made out, I now obtained an explanation both of the micropyle-apparatus and of the trefoil-like appendages in Asellus. *The micropyle-apparatus in the back of Cuma and the Edriophthalma is nothing but the remains of the dorsal spine of Zoëa, or rather, as I have reason to believe, of the larval form of the Cirripedes, which I call Archizoëa, being of the opinion that it is from this larval form Zoëa has taken its origin.*

The second conclusion is: *the larval-membrane of Edriophthalma and Cuma is nothing but the last remains of the carapace of Nauplius,* I mean the nauplius of the cirripeds, which differs

from the nauplius of copepoda by possessing already the dorsal spine on the back of the body and a fork on the underside. I further will distinctively apply to this shape of nauplius the name of *Nauplius;* and to the copepod-nauplius, as being the more simple, the name of *Archinauplius.*

The third conclusion is: *the trefoil-like appendages of Asellus are the last remains of the Zoëa state, representing the carapace, the spines on the sides of the carapace and the respiratory apparatus of the Zoëa.*

After these results I had to apply the inductive method to get further advances in regard to the other classes of the Arthropoda. It is known, that the so-called micropyle-apparatus is to be found in the embryo of Scorpio, of Ixodes, of Pentastomum, and of almost all Araneidæ. *That is one of the indubitable signs, that these animals originate from the Archizoëa.*

The excellent work of Newport on the development of Myriapods furnishes me with the material to state quite the same of this class of Arthropoda.

It is further known and especially stated by Mecznikow, that in the embryo of Scorpio we meet with the so-called "amnion," and that this amnion consists of two walls connected one to the other by small cellular processes. Mecznikow tells us, that the outer wall was an epithelium and the inner a muscular membrane, which is an error, for the whole amnion is nothing but the carapace of Zoëa, which always consists of two walls connected by small processes for the purpose of respiration.

And further, since the "amnion" of scorpio consists of the same cells as the amnion in insects, we are forced to apply the same character to that and to take it for the remains of the Zoëa-carapace. We are the more authorised to do so, because I found out after lengthened enquiry, that even the larval-membrane in Edriophthalma is not quite destitute of cells, or a mere cuticular formation, as it was considered to be, but that in the Oniscidæ and in Idothea cells are visible, which in the other species are soon lost. The "amnion" in insects and the larval-membrane in crustacea are both fastened to the back of the embryo, and if the heap of cells, now known as the remains of

the dorsal spine of Archizoëa be compared with the relics of the amnion in the back of the Phryganea-embryo and of almost all other insect-embryos, their identity will be recognised.

If this be the case, and I hope I have given some proof of it, and will give much more in my longer paper, the homologies of all parts of the insects, spiders, myriapods and crustacea, may be decided. Where then are the homologous parts of the two pairs of antennæ of the crustacea, since in insects we only meet with *one* pair of antennæ?

In considering this question, it is well to examine along with these two pairs of extremities in the crustacean the next pair, the *mandibles,* because these three are developing at first in the crustacean embryos and in a peculiar manner quite different from the next two pairs; and these next two pairs are different in their development from the following pairs. The difference is this. The first three are growing from the back of the embryo, the next two to the ventral side; the first three diverge, the second two converge. *The first three pairs are homologous to the three pairs of the extremities of Nauplius.* In the embryo of insects the first three pairs of extremities are formed exactly in the same manner as in the crustacea; a fact, that is already stated by Professor Zaddach in the Phryganidæ. But into which parts in the full-grown larva of Phryganea do these three pairs develope? It is usually thought into the antennæ, the mandibles and the maxillæ. But this is not the case, for the first pair become the mandibles, the second pair the maxillæ, the third pair, in connexion with another formation, which corresponds to a similar formation in the crustacea, the under-lip.

But where are the antennæ? In a very early stage of the Cuma-embryo a small and almost imperceptible line above the insertion of the second and third pair of maxillæ may be found. This line bends upward at both corners and forms a little plate, which after some time grows on towards the head, so that its under-corner on the side of the antennæ is prolonged, and a small appendage comes out of its under-side and grows on to the ventral side. The plate grows further and further, turns round till it reaches the top of the head and the appendage follows this direction. *The plate developes into the carapace,*

and its appendage into the already described branchial-apparatus.

The way in which the antennæ of insects develope is the following. On the sides of the head a part of the so-called faltenblatt, already mentioned as a first formation in the embryo of insects, remains. On the under-corner of this part, which forms a plate, a little appendage is to be seen, which grows in the direction towards the ventral side. During the further development of the embryo this plate changes its position, and in the same period, when the forehead with the upper-lip—a mere prominence in all Arthropoda—is bent backwards, the plates are growing on forwards and ultimately the outgrowing appendages are situated beyond the mandibles. If we now remember that the faltenblatt is homologous to the inner wall of the Zoëa-carapace, and therefore to the inner wall of the Cuma-carapace, *the plate in Cuma and Phryganea are identical; in the first it becomes the carapace, in the second the head-plate (Scheitel, or Kopf-platte of the German embryologists). The appendage in Cuma becomes the top of the branchial apparatus, in Phryganea the antennæ.*

These observations will I think cause the study of the Morphology of the Arthropoda to enter on a new direction. It is by the application of those principles which science owes to Darwin, that difficulties may be overcome which have been in in our way for more than half a century, since Savigny at first undertook in vain to point out the homologies of the segments and extremities of insects, spiders, myriapods, and crustacea, in which fruitless though very arduous exertions he was followed by almost all the leading zoologists down to this day.

ELECTROTONUS. *A Physiological Demonstration given in the Physiological Laboratory of the University of Edinburgh,* by WILLIAM RUTHERFORD, M.D., *Demonstrator of Practical Physiology.*

GENTLEMEN,

You have already witnessed the fact, that when a continuous galvanic current of equable strength is passed along a motor nerve, contraction of the muscles supplied by the nerve takes place only when the current begins or when it ends, and that *during* the passage of the current the muscles remain at rest. From this fact you might suppose that the nerve is unaffected *during* the transmission of the current, but it is not so; the current all the while it traverses the nerve induces in it a peculiar state, termed the electrotonic state or simply electrotonus.

This state of the nerve is characterised by a variation, 1st, in the degree of its excitability, 2nd, in the rate at which the nervous influenee is transmitted by it, and 3rd, in its electromotive power. In fact, in the state of electrotonus, the whole physiology of the nerve is altered, and the extent of the alteration is directly proportionate to the strength of the continuous current employed.

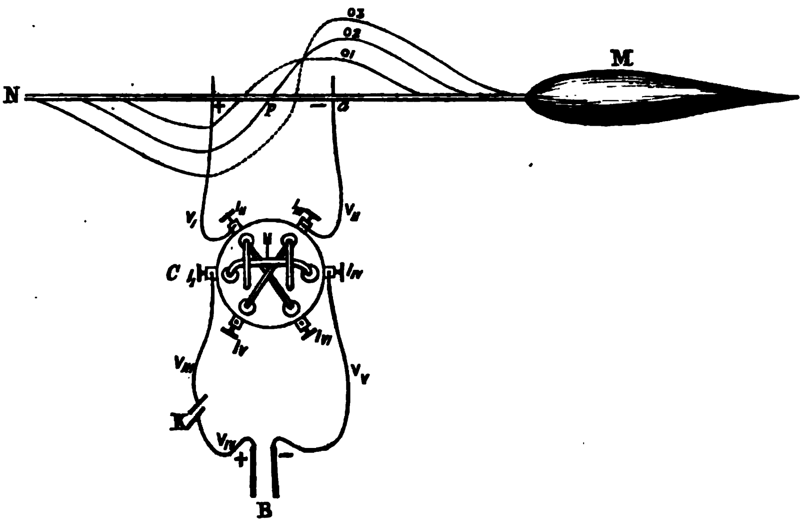
These changes I hope to demonstrate to you in motor nerves: it is probable that precisely the same variations characterise the electrotonic state in sensory nerves; this indeed has been shown to be the case as regards the excitability and the electromotive force, but the variation in the rate of sensory nervous conduction has not yet been demonstrated.

I propose to show you in the first instance the *Electrotonic variation of the excitability.*

I have here the lower part of a frog's limb amputated at the middle of the thigh. The sciatic nerve has been isolated in its whole extent, its attachment to the gastrocnemius only being preserved. I fix the femur in a pair of strong brass forceps supported by a stand. I place the limb in a horizontal position with the gastrocnemius uppermost, so that when relaxation follows moderate contraction of the latter, the limb may by its own weight recover its former position.

I place the nerve (N) on a pair of zinc wires ($V_{\prime}$, $V_{\prime\prime}$ Fig. 1), which are insulated by cork, and supported at a convenient height by a stand. I connect the wires with a Pohl's Commutator[1] (C), and it in turn with a Du Bois Reymond's Key[2] (K),

Fig. 1.



Gastrocnemius, M. Sciatic Nerve, N. Commutator, C. Key, K. Battery, B. Wires from commutator to nerve $V_{\prime}$, $V_{\prime\prime}$, from battery to commutator $V_{\prime\prime\prime}$, $V_{\prime v}$, V_{v}.

[1] Pohl's commutator consists of a circular piece of mahogany an inch in depth and four inches in diameter. A minute description of the instrument would be tedious, suffice to say, that the wires from the battery, or induction machine, are always connected with $I_{\prime}$ and $I_{\prime v}$. When the instrument is used to reverse the direction of a current, the pair of wires in which the current is to be reversed are connected to $I_{\prime\prime}$ and $I_{\prime\prime\prime}$; and the direction of the current is changed by simply turning the arched handle H on the upper surface of the instrument so that its branches may at one time dip into the mercurial cups near $I_{\prime\prime}$ and $I_{\prime\prime\prime}$, at another, into those at I_{v} and $I_{v\prime}$. The instrument may also be used to send a current at one time through one pair of wires, at another time through another pair. For this purpose the oblique wires are removed from the surface of the instrument, and one pair of wires are connected with $I_{\prime\prime}$ and $I_{\prime\prime\prime}$, and another with I_{v} and $I_{v\prime}$. The current will pass through the one pair where the handle is connected with the cups at $I_{\prime\prime}$ and $I_{\prime\prime\prime}$, and through the other when it is connected with the cups at I_{v} and $I_{v\prime}$.

[2] See Appendix A.

(with which the electrical circuit may be closed and broken), and a Grove's battery (B), in which about twelve square inches of zinc are exposed to the action of the acid (one part of ordinary sulphuric acid to eight parts of water). That you may better comprehend these arrangements, I will represent them by a diagram.

When the key is closed and the handle (H) of the Commutator is in the position represented in the diagram, the current must pass from $I_{,}$ to $I_{,,}$ along $V_{,}$ down the nerve, that is, towards the muscle. In that case the negative pole will be the wire nearest the muscle. But if the handle be turned so that its curved branches will no longer be in connection with the cups at $I_{,,}$ and $I_{,,,}$ but with those at I_{r} and $I_{r,}$, the current will pass from $I_{,}$ to I_{r} along the oblique wire from I_{r} to $I_{,,,}$ and thence to the nerve, so that in this case the wire nearest the muscle will be the positive pole.

Now the arrangements for our experiment are completed, we have only to close the key, and a continuous galvanic current will flow through the nerve. But how shall we find out whether or not any variation of the excitability is produced during its flow? Bear in mind this fundamental fact, that the result of irritating a tissue will depend, 1st, on the nature and strength of the irritant, and 2nd, upon the irritability or excitability of the tissue. For example, if I give my finger a slight prick, I produce slight pain; if I give it a severe prick, the pain is intense; but if I freeze my finger, and then prick it, no pain results, not because the irritant has been affected by the cold, but because the irritability has been suspended. A convenient irritant for the nerve in this experiment is a saturated solution of common salt, as recommended by Eckhard. I apply a drop of it to the nerve (at *a*) between the muscle and the nearest wire, about a quarter of an inch distant from the wire, so that the influence of a current passing along the wire may extend to the spot where the drop of salt is placed. We wait until slight tetanus of the muscles results from the action of the salt upon the nerve, and then remove the superfluous drop with blotting-paper in order that the tetanus may not become too marked. Now close the key. You observe that the tetanus

is instantly increased. Pay no attention to the *sudden* increase, for you know that a nerve is irritated at the moment of closing or opening a constant current, but observe that the increase of the tetanus continues during the passage of the current. Now by means of the Commutator reverse the direction of the current in the nerve. You see the tetanus is diminished, and continues to be less marked than it was before the current was sent through the nerve at all. Now open the key. (You thereby stop the current.) Notice, the tetanus becomes very nearly what it was before the current was sent through the nerve. If you examine the arrangements you will see that when the tetanus was in the first instance increased, the wire nearest the irritated spot must have been the negative pole, and that when the direction of the current was reversed, this wire must have constituted the positive pole. But it does not necessarily follow, that because the tetanus was more marked when the negative pole was nearest the irritated spot than it was when the positive pole was in that position that therefore the influence of the + pole is the reverse of that of the − pole, for it may have been that the nerve was becoming exhausted by continued passage of the current, and that in consequence of this the tetanus was diminished. To meet this objection, we repeat the experiment in an inverse order. We will bring the irritated spot first under the influence of the + and then under that of the − pole. You see the phenomena are the same, though their order is changed. When the irritated spot is brought under the influence of the + electrode, the tetanus of the muscle is diminished, whereas under the influence of the − electrode it is increased. We certainly cannot explain these two facts by supposing that the current alters the irritant; for the same results are obtained when a mechanical irritant is used, so that we are compelled to believe that they are due to a variation of the excitability of the nerve, that while the − electrode increases the excitability, and thereby augments the effect of the irritant, the + electrode lowers the excitability, and thereby diminishes its effect. You observed that the salt was placed on the nerve at a little distance from the wire along which the electricity passed, and moreover on a portion of

nerve which did not form a part of the electrical circuit; so that we have proved that the electrodes or poles influence the parts of the nerve which do not lie between them; in other words, the extrapolar as distinguished from the intrapolar portion.

It would require a great number of experiments to ascertain the distance to which a current of any strength extends along the extrapolar portion of the nerve, and it would take too much time to demonstrate the variation of excitability in the intrapolar portion of the nerve; I must therefore simply tell you what has been ascertained by Prof. Pflüger[1] of Bonn. The facts which I have shown you, however, were discovered by Prof. Eckhard[2] of Giessen.

Pflüger found that the distance to which the influence of the constant current extends along the extrapolar portion of the nerve, and the degree to which the excitability is raised or lowered, are in direct proportion to the strength of the current employed.

We may indicate the variations of excitability by curved lines, drawn *above* the nerve in the diagram when the excitability is increased, and drawn *below* the nerve when the excitability is diminished. I will draw three lines ($O_1 O_2 O_3$, Fig. 1) above the extrapolar portion of the nerve near the negative pole, and three below the nerve in the positive extrapolar portion. The three lines indicate three degrees of the excitability. O_1 produced by a weak current, O_3 by a strong current, and O_2 by a current of medium strength. The lines are farthest separated from the nerve at the respective poles, because there the polar influence is most marked, becoming less and less as the distance from the pole increases. While this is true of the extrapolar portion of the nerve a somewhat different story must be told of the intrapolar portion. With a current of medium strength this part of the nerve is divided equally between the two poles, the half on the side of the negative pole having its excitability raised while the other half has it lowered. The one pole seems to neutralize the influence of the other, so that

[1] Pflüger, *Untersuchungen über die Physiologie des Electrotonus.* Berlin, 1859.

[2] Eckhard, *Beiträge zur Anatomie und Physiologie.* Heft I. 1855.

at a point equidistant from the two the excitability is unchanged, and this point is in consequence termed the neutral point, or point of indifference (p). When a weak current is used the neutral point approaches the + pole, while with a strong current it approaches the − pole. In other words, in a weak current the − pole rules over a wider territory than the + pole, whereas in a strong current the + pole prevails.

The shifting of this neutral point is really a most curious fact, which has received no explanation.

You see then that the influence of the + pole, or anode, is opposed to that of the − pole, or cathode; the condition produced by the anode is therefore termed Anelectrotonus, while that produced by the cathode is termed Cathelectrotonus, these form, as it were, the two halves of electrotonus.

We have shown by this experiment that the influence of the − pole is that of a *latent stimulant*, it increases the excitability; whereas the + pole is a *sedative*, it lowers the excitability. And I think this shows us that when we employ a continuous galvanic current with a view to remedy diseased conditions of the nervous system, we ought to subject hyperæsthetic portions as much as possible to the influence of the + pole and anæsthetic portions to that of the − pole. I will however discuss this more fully on a future day.

We shall now perform another experiment, in order to see what is the *Electrotonic variation of the rate of nervous conduction;* that is, of the rate at which the nervous influence is transmitted by the nerve trunk. Already this interesting subject has been investigated by Professor von Bezold of Jena. I will tell you, however, what his conclusions are when we have performed our experiment.

I take for granted that you remember the manner in which, by means of Helmholtz and Du Bois Reymond's myograph, we calculated the rate at which the nervous influence travels in the sciatic nerve of a frog[1]. We will repeat that experiment, with this novel feature however, that we will make arrangements similar to those employed by us in the experiment you

[1] See Appendix B. The reader is requested to read the description of the instrument and experiment in the appendix ere he proceed with the above.

have just seen, for passing a constant current through a portion of the nerve. A diagram will enable you to understand the experiment. (Fig. 2), Sciatic nerve of frog (*n*), gastrocnemius (*m*), wires for continuous current I connected with the same arrangements as in the previous experiment (Fig. 1). Two pairs of wires (II and III) with which to irritate the nerve by an induction shock, at one time close to the muscle, at another close to the pole of the constant current which is nearest the muscle, our object being in this, as in the former experiment on this subject (see Appendix B), to ascertain the time taken by

Fig. 2.

the nervous influence to pass from the part of the nerve on the wires at II to that on the wires at III.

After the experiment which you have just witnessed you will readily understand that when a constant current is passed from 1′ to 1″—1″ being in that case the negative pole—that a portion, if not all, the nerve lying between 1″ and the muscle will be thrown into the Cathelectrotonic state; while, if the constant current be reversed, 1″ will become the positive pole, and the tract of nerve just mentioned will be thrown into the Anelectrotonic state. We will again employ a single Grove's cell as the source of the constant current.

I dissect out a perfectly fresh sciatic nerve with its gastrocnemius, and connect it with the machine.

Before passing the constant current through the wires I we make two tracings on the blackened cylinder, by irritating the nerve at III and at II, from which we can afterwards calculate the normal rate of conduction *in this nerve.*

That being effected I now elevate the stilette connected with the muscle, in order that the next tracings may be made upon a higher part of the cylinder, and may therefore not interfere with those which we have just obtained.

Now, we send the constant current through the nerve at İ, so that 1″ may be the negative pole, and within a minute after the closure of the constant current, obtain another pair of tracings by irritating the nerve at İİ and İİİ. We open the constant current and allow the nerve to rest for a minute. I again alter the position of the stilette, so that another pair of tracings may be made on a new part of the cylinder.

Lastly, we again pass the constant current between 1′ and 1″, making however 1″ the + pole in this instance.

We get another pair of tracings, and now we will print the tracings on a sheet of moistened gelatine.

Fig. 3.

The horizontal lines /, //, ///, are produced by the contact of the stilette with the smoked cylinder during its revolution while the muscle is at rest; whereas the curved lines are due to the contractions of the muscle: the first curve (o) in each pair being produced by contraction of the muscle following irritation of the nerve at İİİ (Fig. 2), while the second curve (s) in each pair is due to irritation of the nerve at İİ (Fig. 2). The lowest pair of curves is obtained by irritating the nerve in its normal state; the middle pair by irritating the nerve in its cathelectrotonic state; while the highest pair was obtained from the nerve in its anelectrotonie state. The distance between o and s in each pair indicates the time taken by the nervous influence to pass from the part of the nerve at İİ (Fig. 2) to that at İİİ (Fig. 2). You see at a glance that the distance between o and s is much shorter in the middle pair than in the other two; this clearly shows that in the cathelectrotonic state the nervous influence has travelled faster than it has done in the normal

state of the nerve: while, on the other hand, the distance between o and s in the highest pair is the greatest, showing that in the anelectrotonic state the nervous transmission has been slower than in the normal state. You see, however, when you compare the highest and lowest pairs of tracings, that the difference in the distánce between o and s in each is not so great as is the difference between the lowest and middle pairs in this respect, from which it appears that the – pole, under whose influence the middle pair of tracings was obtained, has had a greater influence on the rapidity than the + pole, under whose influence the highest pair of tracings was produced. This may perhaps be accounted for by the fact that the + pole had to act on the nerve after previous excitement of the latter by the negative pole; but it may also be explained by supposing that, with a current of the strength employed by us, the – pole is more influential than the + pole. I have so often obtained a result so nearly the same as that of this experiment that I have no hesitation in saying that our conclusion must be that in the electrotonic state, induced by a constant current of medium strength, the negative pole quickens the rate at which the nervous influence is transmitted, while the positive pole slows it. This conclusion, however, is quite at variance with that at which Prof. von Bezold of Jena has arrived. According to that physiologist the rapidity of nervous transmission is diminished by both the + and the – poles of a constant current (*über die Electrische Erregung der Nerven und Muskeln*, 1861, pp. 109—155). I would not presume so decidedly to differ from von Bezold's general conclusion were I unable to account for the variance between his results and those of which you have just seen a specimen, but the explanation is, I believe, simply this, that, while von Bezold used a very strong constant current, we have employed one of medium strength. The current used by von Bezold was nearly the whole strength of that divided from a battery consisting of *seven* Grove's cells; whereas our current has been derived from only *one* such cell; and I believe that the Grove's cells employed by him and by us are essentially the same. Moreover, von Bezold allowed his strong current to act on the nerve *for at least three minutes* before making the obser-

vations, while we have not allowed our comparatively weak current to act *longer than one minute* before each observation was completed. That this is the explanation I feel convinced, because when I take *seven* Grove's cells and connect them with the myograph and a rheocord, exactly as von Bezold directs, and allow the current to act for three minutes ere I make the tracings, I get the same result as he obtained, viz. slowing of the rate of nervous transmission produced by the – as well as by the + pole. But the effect of such a current on a nerve is so severe that its excitability ere long disappears; indeed I generally find that after it has acted for three minutes on a nerve the excitability is considerably lowered even in the region of the – pole, and I believe that in such a case the rate of nervous conduction is lowered in the Cathelectrotonic region *because the excitability is lowered.* We know that a low temperature lowers nervous excitability, and Helmholtz has shown us that it diminishes the rate of nervous conduction, while a high temperature has the opposite effect on both; we can now therefore say that, like cold, the + pole of a constant current acts as a sedative to a nerve, diminishing its excitability and the rate of conduction, while the – pole of a current of the strength employed by us acts as a latent stimulant in increasing the excitability and the rate of conduction: and I believe that it will be found to be a law, that whatever increases or diminishes the excitability of a nerve has at the same moment a similar effect upon the rate of transmission of the nervous influence; and, indeed, so far from looking upon the *excitability* and the *conductability* (if I may use such a term, for a nerve is not simply a conductor but also a generator of nerve force) as two quite different things, as some do, I feel much inclined to think that they are essentially the same.

Our two experiments show us then that the + pole of the current we have employed lowers the nervous excitability and the rate of its conduction, while the – pole increases the excitability and the rate of conduction.

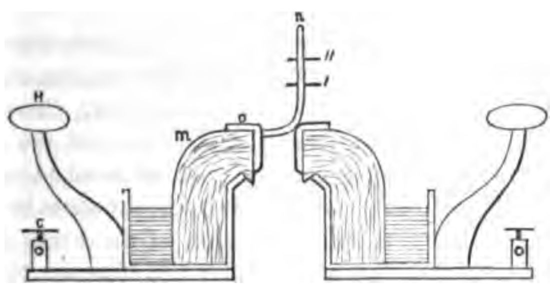
Our final experiment will be on the *Electrotonic variation of the electromotive power.*

You remember that the other day I demonstrated to you

the existence of an electrical current in living muscle and nerve, and I showed you that the current was diminished in both when they were irritated and thereby thrown into action. I will now show you the variation produced in the nervous current by the electrotonic state.

I remove the whole length of a fresh sciatic nerve. I make an accurate transverse section near its one extremity, and place that transverse section in contact with the plate of moist clay (o) (Fig. 4) on the cushion (m) of one of the galvanometer troughs (see Appendix C). I lay the longitudinal surface of the nerve (n) on the cushion of the other trough, and lastly lay the nerve upon a pair of wires / and //, connected with the same arrangements as before, for generating and directing the continuous current.

Fig. 4.



Vertical section of Du Bois Beymond's improved troughs for the Galvanometer. m. Cushion of blotting paper dipping into a concentrated solution of sulphate of zinc in the trough. o. Plate of moist clay to protect the tissues from the action of the sulphate of zinc. H. Handle to move the trough. c. Brass pillar for attaching a wire to connect the trough with the Galvanometer. n. Nerve.

As yet no *artificial* current has been sent through the nerve between / and //, and you see the slight but distinct deflection of the needle of the galvanometer which is produced by the electrical current derived from the nerve. Now we subject the portion of nerve which is generating that current, viz. that between the cushions, to the influence of the + pole of the continuous current, that is, we make / the + pole; observe, the

galvanometer needle is much farther deflected in the direction which the natural or nervous current had caused it to assume. Reverse the direction of the *artificial* continuous current, so that the nerve between the cushions will be brought under the influence of the − pole. You see the needle returns to zero, indicating thereby the diminution or even abolition of the current developed by the nerve. We repeat this experiment in an inverse order, and you see the results are the same. But you may say, Are these effects of the continuous *artificial* current not due to passage of a portion of the artificial current along the nerve, and through the coil of the galvanometer—strengthening when it passes in one direction, and neutralising when it passes in the other—the influence of the natural nervous current upon the needle? A simple experiment will settle that question. I have here a *dead* nerve. I arrange it on the cushions and the wires exactly as I did the living one: of course the needle is motionless, because a dead nerve does not generate electrical force. We send the continuous current in both directions as before—*the needle remains motionless; but a dead nerve conducts electricity just as well as a living one;* therefore the needle variations which followed the transit of the artificial current through the living nerve cannot be ascribed to passage of the artificial current round the needle, but must be referred to variations of the electromotive power of the nerve produced by the electrotonic state; and we may therefore say that while the + pole of a continuous current increases, the − pole diminishes the electromotive power of a nerve. This effect of a continuous current on a nerve was discovered by Prof. Du Bois Reymond of Berlin; and it was the discovery of this fact which led to that of the others which I have shown you.

If we now compare the results of our three experiments, we have these startling facts brought out. *In Anelectrotonus the excitability and the rate of nervous conduction are diminished, while the electromotive power is increased: whereas, in Cathelectrotonus, the excitability and the rate of nervous conduction are increased, while the electromotive power is diminished:* this is, I believe, *the law of Electrotonus.* Remember, however, that I have been showing you all along the effects of a constant

current of medium strength, and that this law is deduced from the effects of such a current. A very strong current when passed along a nerve soon kills it, and the final loss of excitability takes place first at the − pole, where the first action of the current is to increase it. It seems as though the − pole, by its latent stimulation, made the nerve *live faster*, while the + pole, by its sedative influence, causes the nerve to husband its strength.

A crowd of theoretical considerations surrounds this most interesting subject. Are the changes which constitute Electrotonus due to electrolysis of the nerve? Does the − pole increase the development of *nerve* force from chemical force, while it hinders its conversion into electrical force, and *vice versa* with the + pole? Is increased excitability of a nerve due to a higher tension of the *nerve* force, whereby its discharge is rendered more easy? and, inasmuch as increase of the excitability is accompanied by a diminution of the electromotive power, just as positive action of the nerve is, do excit*ability* and excit*ement* not stand very closely related as regards the development and expenditure of nerve force? But we have already exhausted our time, and must postpone these considerations until our next demonstration, when I will show you the facts on which are based the law of nervous irritation, or as Pflüger termed it, the "law of contraction"—that law governs the phenomena produced by the *establishment* and *resolution* of Electrotonus.

APPENDIX.

A. *Key*. The best key for closing and opening the circuit in electrical experiments is that (Fig. 5) invented by Du Bois Reymond. It consists of a plate of Vulcanite *I* to which are fixed two brass bars *II* and *III* for attaching wires. Fixed to one extremity of bar *III* is a short brass beam *IV* with an ivory handle. Suppose the key

included in the electrical circuit in the manner indicated in Fig. 1; as long as the brass beam *IV* remains in the position indicated in the figure, the circuit is open, for the electricity cannot pass from *II* to *III* through the insulating vulcanite: but if the raised end of the beam be lowered so as to bring it in contact with the bar *II* the circuit will be closed. The friction of the beam *IV* against the bar *II* keeps the contiguous surfaces bright and clean, so that the very closure of the key removes any film that might impede the passage of the current. The screw *V* is used for fixing the key to a table.

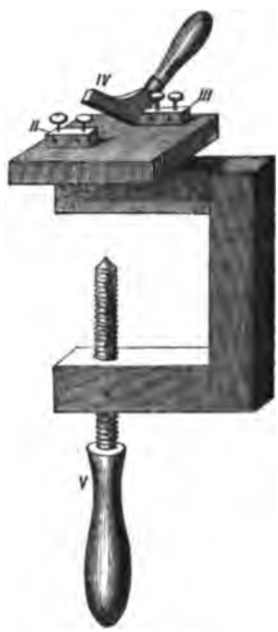


Fig. 5.

B. Helmholtz and Du Bois Reymond's Myograph.—This instrument was invented for the purpose of measuring the rate of nervous conduction, and to enable us to study muscular contraction[1].

The following is a description of the instrument arranged to measure the rate of nervous conduction—and also of the experiment, which with this instrument can only be performed, with the sciatic nerve and gastrocnemius muscle of a frog.

The instrument consists of three principal parts.

1. A brass cylinder, two inches in diameter and about an inch and a half in height, turned by clockwork, provided with a dial by which the rate of the cylinder's revolution may be ascertained with the greatest precision. The cylinder's surface is covered with glass, which is smoked before each experiment in order that a tracing may be made upon it by the point of a stilette. 2. Arrangements for holding the muscle and nerve, and for connecting the former with the stilette. The femur of a frog having the gastrocnemius attached to it is fixed in a pair of strong brass forceps; and the tendon Achilles is connected by hooks with a moveable lever having at its free extremity the stilette for writing upon the cylinder; when the muscle contracts, the lever is raised, and the stilette produces a tracing corresponding

[1] For the latter purpose it is not so well adapted, inasmuch as the lever to be moved by the contracting muscle is so heavy that the momentum it acquires in its movement destroys the finer vibrations produced by the muscle. Marey's myograph has superseded it for this purpose (*Journal of Anatomy and Physiology*, No. 1).

to the contraction. The muscle and nerve are surrounded by a glass case containing wet blotting-paper to keep the tissues moist. 3. Arrangements by which the sciatic nerve connected with the muscle is irritated at a given point of time. The nerve is irritated by the shock of an induction apparatus, produced by suddenly breaking the constant current passing from a battery through its primary coil. Two pairs of wires are placed in contact with the nerve; one pair (İİİ Fig. 2) as near the entrance of the nerve (n) into the muscle (m) as possible, and the other (İİ) at a part of the nerve, say two inches distant from the muscle. The wires are connected with a simple contrivance termed a commutator (see note page 88), by means of which the shock from an induction machine can be sent through the one pair of wires or through the other; the object of the whole experiment being to ascertain how long the nerve force takes to travel from the part of nerve in contact with the one pair of wires (İİ) to that in contact with the other (İİİ). The part of the instrument by which the electrical current is broken, and irritation of the nerve thereby produced at a given moment, consists of a round brass box fixed to the axle of the cylinder and rotating with it. The box contains a moveable weight, and as it revolves the weight by centrifugal force moves outwards, and on reaching a certain point suddenly breaks the electric circuit, and thereby induces irritation of the nerve and contraction of the muscle. By means of the dial upon the clockwork the rate of the cylinder's revolution just when the current is broken can be accurately ascertained. By means of a spiral spring attached to the weight in the brass box the rapidity with which the weight moves outwards may be regulated; we may so arrange the spring that the weight will reach the side of the box, and break the current when the cylinder is making 10 revolutions or 15 revolutions in a second, and so on. Fifteen revolutions in a second is the most convenient rate. The instrument above described is Du Bois Reymond's modification of the original instrument invented by Helmholtz. The modification consists in the arrangements for breaking the current at a given time. In Helmholtz's instrument this is effected by centrifugal balls, but the arrangement adopted by Du Bois Reymond is more compact and works with greater precision. The electrical arrangements being made the experiment is begun. 1. The velocity of the cylinder's revolution at the moment the current is broken is ascertained: let us suppose that it makes exactly 15 revolutions in a second. The circumference of the cylinder being 6 inches, $15 \times 6 = 90$ inches linear of surface of cylinder, equivalent to a second of time. 2. The cylinder's surface is blackened by causing it to revolve rapidly in the smoke of a turpentine lamp. 3. The gastrocnemius and sciatic nerve of a frog are dissected out, and attached in the manner above indicated. 4. The commutator is arranged so that the induction shock will pass through the portion of nerve near the muscle (İİİ): the clockwork is set in motion, and is stopped when contraction of the

muscle has taken place. 5. The machine is arranged exactly as before with this single exception, that the commutator is turned so that the induction shock will be given to the portion of nerve at two inches distance from the muscle (İİ). 6. The clockwork is put in motion, and the contraction of the muscle again produced. 7. The cylinder is then rolled along a thin sheet of moist gelatine, on which a print of its tracings is thereby obtained.

If the experiment have succeeded well, the print will show three tracings (see the lower third of Fig. 3). 1. A horizontal line (*l*) produced by the contact of the stilette with the cylinder during its revolution while the muscle is at rest. 2. A curve (o) produced by contraction of muscle when the nerve was irritated near the muscle. 3. A second curve (s) produced in the same manner when the nerve was irritated at a point two inches further from the muscle than the first point. The distance between these two curves at their commencement, that is, at their point of contact with the horizontal line—must necessarily be equivalent to the time taken by the nervous influence to pass from the part of nerve over the wires at İİ, to that over them at İİİ. The two curves are, let us say, $\frac{1}{6}$th of an inch apart. What is the value in time of this interval? Ninety inches of the cylinder's surface having been found to be equivalent to a second, $\frac{1}{6}$th of an inch must necessarily equal $\frac{1}{540}$th part of a second. If the nervous influence take $\frac{1}{540}$th of a second to travel along 2 inches of nerve, how long will it take to travel 12 inches? $\frac{1}{90}$th of a second. If, then, it take $\frac{1}{90}$th of a second to pass along one foot of nerve, it will of course travel at the rate of 90 feet per second. In frogs' nerves prepared in the above manner the rate varies from 75 to 120 feet per second. The rate depends much upon the temperature to which the nerve is exposed, being slackened by low, and quickened by high temperatures. If the nerve be allowed to dry a little, the rapidity is greatly increased. The experiment should be made with perfectly fresh and healthy frogs, for when frogs have been kept long without food the nerves become so weak that the manipulation necessary for the experiment produces such excitement that the nervous influence travels with a rapidity too great for measurement by means of this instrument.

C. Troughs for the galvanometer. The porcelain troughs with the platinum plates and solution of salt, at first used by Du Bois Reymond, have for several years been superseded by another of his ingenious contrivances, viz., troughs of zinc measuring about 2½ inches in any direction (Fig. 4). The inner surfaces of the two troughs are amalgamated, and contain a concentrated solution of sulphate of zinc. This arrangement does not give rise to the secondary currents which are so distressing when the old apparatus is used. A pad of blotting-paper (m) is folded over the side of either trough, dipping on the one hand into the saturated solution of zinc, while on the other it presents a free edge on which a thin layer of potter's clay (o) previously

moistened with a dilute solution of common salt or saliva, is laid. The muscle or nerve is always laid upon this clay in order that they may not come in contact with the corroding solution of sulphate of zinc, by which the layer of organic matter in immediate contact would be killed. These clay plates serve instead of the bladder and albumen in the old arrangement, and answer the purpose far better than these, inasmuch as they can always be made from the dry pulverised clay on very short notice, and form more perfect conductors than the other substances.

The zinc trough is fixed upon a plate of vulcanite to insulate it.

When small nonpolarisable electrodes are required, *e.g.* to examine the electrical condition of different points of a muscle or for irritating nerves when it is important to avoid all secondary currents, another arrangement of Du Bois Reymond's answers the purpose. It consists of a little glass tube, open at both ends and supported on a stand; in the tube is placed a thin strip of amalgamated zinc connected outside the tube with an ordinary conducting wire, the other end of the tube is closed with moist potter's earth drawn to a point at its free extremity; and the tube is filled with saturated solution of sulphate of zinc.

A pair of such tubes is always required,—of course the wires from the zinc plates may be connected with a galvanometer, or with a battery.

ON SOME NEW METHODS OF PRESERVING THIN SECTIONS OF BRAIN, OR SPINAL-CORD, FOR MICROSCOPICAL EXAMINATION. By H. CHARLTON BASTIAN, M.A. M.D. Lond.

FOR some time past the method of Lockhart Clarke, for preserving and mounting thin sections of hardened brain or spinal-cord, has been almost exclusively adopted both in this country and on the continent. Preparations mounted by this method, after the previous staining with carmine, are most satisfactory, not only on account of the distinctness with which the proper structure of the tissue can be made out, but also on account of the durability of the specimens, which, being imbedded in balsam, seem to undergo no appreciable change in the course of years. Though the finished result is thus satisfactory, the time necessary for its completion is inconveniently long, inasmuch as some hours must elapse between the tinting of the section and its final mounting in Canada balsam. When engaged in an investigation this delay often proves vexatious, and principally on this account efforts have been made of late either to modify Clarke's method, or to introduce a new one.

The delay in Lockhart Clarke's method is due to the fact of his using turpentine, in order to give the section its proper degree of transparency, and the comparative slowness with which this is imbibed. The thin section is first immersed in alcohol, in order to get rid of any water with which it may be saturated, and then placed in a flat watch-glass, on a thin stratum of oil of turpentine, in order that this may be imbibed by the section as the spirit evaporates. The longer the time has been during which the section has been immersed in alcohol, the more rapidly is the turpentine imbibed by it; the two processes, however, usually occupy some hours[1].

[1] Schroeder van der Kolk speaks of their extending over twenty-four hours or more. According to my own experience the two processes have rarely occupied less than five or six hours, even with moderately thin sections. In his first paper (*Phil. Trans.* 1851), Lockhart Clarke directs that the section be first macerated in a mixture of acetic acid and spirit "for an hour or two," and then allowed to remain in pure spirit for about the same space of time. In a later paper

Rindfleisch found that, by the substitution of oil of cloves for oil of turpentine, the section may be made transparent in a much shorter time; and quite recently Prof. Ludwig Stieda[1] of Dorpat has strongly recommended creosote, a fluid first proposed by Kutschin[2]. By the use of this agent, instead of oil of cloves, the section may be rendered transparent in two or three minutes. Dr Stieda has also made a number of experiments with the various essential oils, and finds that they may be divided into two groups, the members of one of which resemble oil of turpentine, whilst the others, from their greater rapidity of action, are like oil of cloves and creosote. In the first group are found the oils of orange-peel, juniper, mint, lavender, lemon, savine, and others; whilst in the second he places the oils of cassia, cinnamon, star-anise, bergamotte, cardamoms, and rosemary. None of these are, however, superior to the oil of cloves, and creosote is, he thinks, much superior to this last; therefore he deems further experiments in this direction unnecessary. My objections to the use of creosote in the manner advised by Prof. Stieda will be stated presently.

In the spring of this year, before I was aware of these modifications of Clarke's method, I had been making some experiments myself with the view of bringing about a more speedy saturation of the section with turpentine. I first tried the agency of heat: after immersing the section for a quarter of an hour in strong spirits of wine I took it out, placed it on a drop of turpentine in the centre of the glass slip on which it was to be mounted, and then carefully heated the glass by holding it over the small flame of a spirit-lamp—never allowing the turpentine to boil or the section to become dry, but keeping it

(*Phil. Trans.* 1859) he speaks of the sections remaining only a few minutes in the acetic acid and spirit, but says nothing concerning the time necessary for the remaining stages of the process. He has lately told me that the imbibition of the turpentine may be much expedited, even after a short immersion in spirit, by tapping with the finger the glass containing the section and the turpentine. But if rapidity of result be desired, I am sure I can endorse what my friend, the author, has himself said concerning his method, viz. it "at first presents some difficulties, and practice is necessary to ensure complete success."

[1] *Schultze's Archiv fur Mikroskopische Anatomie*, II. Heft 4, 1867.

[2] Dissert. Inaugural. Kasan 1868.

moist by adding a fresh drop of turpentine from time to time. In this way, in the course of six or eight minutes, all the spirit was driven off and the section rendered transparent by the turpentine. This was a troublesome process, however, requiring the exercise of great caution to prevent the specimen becoming dry—and even when it was moist, if submitted to too high a temperature, the specimen on a sudden shrivelled and became useless. I therefore tried many other experiments, and at last hit upon one which was much more satisfactory. After immersing the section in strong spirits of wine for about half-an-hour, I took it out, suspended from the edge of a small scalpel; brought its free edge in contact with blotting-paper for a moment, in order to remove superfluous spirit; and then placed it in a covered watch-glass, containing about twenty or thirty drops of pure anhydrous sulphuric ether. In this it was allowed to remain about five or six minutes, afterwards removed in the same way with a scalpel, exposed to the air for a second or two, and then, just as it was becoming dry from the evaporation of the ether, placed on a drop of turpentine in the centre of the glass slip, when the turpentine was immediately imbibed and the section rendered transparent. Canada balsam was then added, and the covering-glass applied. This was a great improvement upon the old method, as it rendered the process so much more rapid, and the ether did not seem to damage the specimen in the least. I mounted many specimens in this way, and continued to do so till I heard of the advantages of creosote. I then made some experiments with this fluid, and also with carbolic acid, which it so much resembles. I found everything true that had been said concerning the rapid manner in which sections were rendered transparent by creosote, even after a previous immersion of only a few minutes in spirits of wine. For one or two hours specimens so prepared and mounted in Canada balsam were satisfactory enough, but in less than twenty-four hours I have always found them much spoiled. The sections become too uniformly transparent, and hence dim, so as entirely to lose all the distinctness of definition characteristic of those prepared by Clarke's method, or by my modification of it. Specimens mounted in this way soon became comparatively

worthless, on this account. I found that liquid carbolic acid[1] acted in almost the same manner as creosote, though it was the more preferable fluid of the two, as it did not seem to make the sections quite so uniformly dim as when creosote was employed.

Hoping that the amount of dimness produced by carbolic acid might be neutralized by the agency of some other fluid, I tried many combinations of successive immersions in various fluids, before finally settling upon three methods, which seem to me in every way satisfactory both as regards rapidity of process, as well as excellence and permanency of result. These three methods are as nearly equal in value as they can be, and the specimens prepared in either way seem to me fully equal to those prepared by Clarke's method, and they appear, also, to be just as durable. Some in my possession have been mounted more than three months, and are now quite as distinct as when the covering-glass was first placed over them.

The *first* method, and that which I usually employ, is this: the tinted section is placed for four or five minutes in a watch-glass with pure spirits of wine, then removed on a scalpel—the superfluous spirit being got rid of by bringing the dependent edge of the section in contact with blotting-paper—and afterwards placed on a drop of carbolic acid in the centre of a glass-slip. In less than two minutes the section is rendered transparent; and when this is accomplished (having got rid of any excess of carbolic acid) I pour over it three or four drops of chloroform, in which the specimen is allowed to remain for two minutes. The superfluous chloroform is then poured off, whilst one or two drops of a solution of Canada balsam in chloroform are dropped over the specimen, and the covering-glass is then quickly applied. The whole process is therefore simple, and extends over ten minutes, even for moderately thick sections, instead of several hours. The *second* method is only a variation of the one just detailed; all the steps are the

[1] The white acicular crystals of this acid readily liquefy on exposure to air owing to the absorption of aqueous vapour, or the same result may be brought about by the addition of a small quantity of water to the bottle in which the crystals are contained.

same, with the exception that the section is steeped for two minutes in ordinary commercial benzine, such as is used for cleaning gloves, instead of in chloroform. The results are equally good in either case, the employment of the benzine causing no sort of precipitate, since it mixes freely both with carbolic acid and with the Canada balsam and chloroform. The *third* method, also equally good, is somewhat different, since carbolic acid is not used at all. The section after saturation in spirits of wine, as before, is transferred to a covered watch-glass containing a small quantity of pure sulphuric ether, in order to drive the alcohol out of the section. In this it is allowed to remain for a few minutes, then the section is carefully removed, and, just as it is becoming dry from evaporation of the ether, it is placed upon a drop of chloroform on the glass slip. The chloroform almost immediately renders the section transparent, and then the solution of Canada balsam and the covering-glass are applied as before. The ether is rendered necessary in this method in order to dissolve the alcohol out of the section, because, after the final mounting, the presence of any of this latter fluid causes the precipitation of the Canada balsam, in a molecular condition, out of its solution in chloroform.

The use of the solution of Canada balsam in chloroform makes the mounting of specimens in this medium perfectly simple; whereas to mount in Canada balsam in the ordinary way requires some amount of practice in order to avoid disappointing results. I have tried solutions of gum dammara and of gum mastic, in chloroform, in ether, and in benzine, respectively, but with none of these compounds could I obtain such satisfactory results as with a carefully prepared solution of Canada balsam in chloroform.

If it be desirable that the specimens of brain or spinal-cord should not be immersed in spirit or ether at all, with the view of better preserving all pathological appearances, this is now quite possible. The hardening should be brought about by the use of bichromate of potash and chromic acid solutions; and the thin sections must be rendered transparent either by the first or second methods just detailed, only,

in each case, omitting the use of the spirits of wine altogether. Sections taken from water or any aqueous solution, and then partially dried, become transparent in about twenty or thirty minutes when allowed to soak in carbolic acid. In ordinary cases, where the spirit of wine is employed, it is only used in order to hasten the process.

Although the methods I have just described are so satisfactory for mounting thin sections of brain and spinal-cord, I cannot recommend them for sections of liver, kidney, or other organs; these, I think, are best preserved in pure strong glycerine, or else in a mixture of three parts of glycerine to one of carbolic acid. This mixture I have been using for three or four months, and, so far, it seems to possess advantages over simple glycerine. The specimen does not become so transparent as when glycerine alone is used, and the details of delicate cellular structures have seemed to be preserved with more distinctness. It is necessary to immerse the sections in spirits of wine for a few minutes, however, before placing them in the mixture of glycerine and carbolic acid, since this last will not mix freely with water.

NOTE ON A THREE-TOED COW. By NEVILLE GOODMAN, B.A., *of St Peter's College, Cambridge.*

SOME time ago I heard that Mr Daintree, of Fenton, Huntingdonshire, had in his possession a heifer with three functional toes, with their hoofs, on each hind limb; the two subsidiary hoofs being in their usual place, on either side and behind the foot. Thinking that this abnormal structure might throw some light on the homologies of the parts of the foot in ruminants, I requested Mr Daintree to send me the whole foot when the animal was killed. This he was kind enough to do, and I found the foot as described.

The abnormal hoof was internal to the other two, and was almost equal in size, and similar in shape, to the external one, being correspondingly curved inward towards the central line; while the central hoof was the largest of all, and though a little curved towards the outer one, was flatter underneath,

and its two edges were more symmetrical than in the normal state.

The bones of the additional digit were complete in number, and as exactly similar to those of the external one as its outward aspect had suggested.

The lower end of the combined metatarsals (cannon bone) had, of course, an additional facet for this digit, but this had not so definite a trochlear ridge, and the process when traced upward seemed to have so intimately coalesced with the normal bone as to leave but very slight indication of anything unusual about it. It is true that at the lower end a slight groove corresponding with that which lodges the anterior artery and nerve between the two ordinary elements of the metatarsals was present, but this died out completely and left the head of the cannon bone with a periphery, such as it would be seen in section, very like that of the ordinary ox.

Singularly however the abnormal growth which seemed to have faded out, reappeared in the tarsal bones and the facets opposed to them by the metatarsal bone. The cuneiform bones were represented by one piece, the coalescence being greater than in the ordinary structure, but this single bone consisted, one would say, from a *prima facie* inspection, of three elements. The small external bone, constant in the normal ox, to which the peroneus longus runs, was there, though intimately united with the next piece; while between it and the cuboid two other pieces, indicated by so trenchant a division that the bones viewed *in situ* from the front seemed to be distinct, were evidently homologous to the single normal element. In other words, the extra piece had not been intercalated between the ectocuneiform bone and that small bone, which, with regard to the ox, may be properly called the entocuneiform, in correspondence to the introduced digit, but was a subdivision of the former.

The lower end of the tibia and the bone representing the malleolar head of the fibula were precisely normal, and to my special enquiry concerning the femur the butcher replied, that "it was exactly like that of any other beast."

The only peculiarities of the muscular system were these.

The flexors had a tripartite instead of a dual subdivision, and the divisions were similar to one another. The internal tendon of the extensor, which runs to have its main insertion on the outside of the second phalanx, sent off a large slip to run to a similar insertion in the extra digit, and this slip gave off another to the last phalanx, where it had a similar insertion to the divisions of the extensor longus digitorum; this muscle being confined to the two normal toes, without sending any division to the extra one.

It is needless to say that the results of the study of teratology must be received with the greatest caution; indeed, they should be looked upon as suggestions only, to be severely checked by the study of normal structures. Moreover, these results seem to be less and less reliable as we proceed upward in the scale of organisms. Nevertheless it cannot be denied that teratology has sometimes yielded good and satisfactory results, which have afterwards been justified by other considerations.

In the present instance I fear no very definite results have been found.

Of course, the crude idea, suggested by this foot, that the digit suppressed in the ruminant is not the inner one, while the second and fifth are left in a rudimentary condition, but that the second is suppressed leaving the first and fifth to represent the spurious hoofs, must be at once rejected.

For while the subordinate functional digits of the Elk and Reindeer consist each of a styliform metatarsal terminating in a point upwards and but two phalanges, a condition quite as consistent with the supposition that they represent the first and fifth as the second and eighth, the Chevrotain has metatarsals complete from end to end, and each with three phalanges.

It might be argued that serial homology in the first-mentioned species would decide the question. I do not think however that serial homology is of much importance in determining general homology.

The serial correspondence of limbs is often most marked and curious, but it is also utterly ignored in many species;

and while there is an explanation of this correspondence in teleological necessity, it is more philosophic to consider it incidental to this, than in itself a law, a law which has no meaning, and has almost as many exceptions as exemplifications.

Thus in this very species, which is one of the most characteristic of the ruminant type, which type may be called the latest and most specialized of the ancient and widely spread order of pachydermata, it is evident that the foot is admirably adapted to the native habits of the bison and buffalo, the wild congeners of our oxen. These fed on the shallows and muddy banks of rivers and marshes, treading the soft earth with their feet.

The foot must therefore not be round and padded like that of the camel, and the metatarsals, though strong and consolidated, must be as compressed as possible, or else to withdraw the foot from the mud would be a matter of difficulty. Again, the foot must not be solid like that of the horse, but cloven, so that, as it sinks in the soft earth by the great weight of the animal, it carries beneath it a wedge, which as it descends acquires a broader base and more solid, resisting consistence.

Of necessity, therefore, independently of the means by which it is obtained, the external characters of the fore and hind limb must be the same. In other animals (as Cetaceans), where the functions are not necessarily the same, the serial homology is not found.

The case of the Chevrotain, however, disposes of the suggestion first named; and I think that this species, conjoined with those of the horse and reindeer, will not allow us to think that the metatarsals 1, 2 and 5 have disappeared in the ruminant by coalescence.

The persistence of the lower ends of the metatarsals in Cervus Alces, and of their upper ends in the genus Equus, (though in this latter case the presence of distinct bones gives rise to inconvenience, which complete coalescence would have apparently avoided), certainly indicates that the cause of disappearance is more generally suppression than coalescence, yet

I do not know that this carries the conviction that coalescence may not have played its part in other species, and the inspection of the upper end of the femur of a ruminant certainly supports such a theory.

With regard to a third suggestion, viz. that while the cannon bone of an ox only represents the third and fourth metatarsals, all three cuneiform bones are impressed into the service of their support, there seems to be some room for enquiry.

In comparing the cuneiform bones of the ox with those of the rhinoceros, one can hardly escape from the conclusion, that the small distinct entocuneiform bone of the normal ox is represented by the upper part of the stunted bone which here represents the whole of the first digit. If in the monstrous structure the division is entirely abnormal, it is certainly curious that this aberration should give rise to a spurious coalescence on the one side, and a spurious subdivision on the other.

On the other hand, on examining the bones of a young calf I found that the division of the facets of the ectocuneiform bones and those opposed to it by the metatarsal were less marked than in the grown ox.

While acknowledging some disappointment in the results of my examination of the abnormal structure, and confessing that they point to nothing conclusive, I thought it advisable to make this note, as perhaps others might view it differently, or that it might suggest some lines of investigation.

That the homologies of the limbs of ruminants require further investigation must be admitted, when we find our most renowned comparative anatomist, in his most recent work, altogether ignores the presence of the entocuneiform bone in the tarsus of an ox, though he grounds the homologies of the phalanges on their connection with the tarsal bones.

The bones of this above-named foot are in the Anatomical Museum of the University.

The animal they belong to gave birth to a calf, which has the same peculiarities with itself.

PRELIMINARY NOTICE OF SOME OBSERVATIONS WITH THE SPECTROSCOPE ON ANIMAL SUBSTANCES. By E. RAY LANKESTER, *Christ Church, Oxford.*

USING one of the spectroscope-eye-pieces made by Mr Browning for Mr H. C. Sorby, and one of the "interference scales" for measurement, I have examined lately various coloured bodies in the lower as well as higher animals, with the following results.

1st. *Chlorophyl in Animals.* I found Chlorophyl distinctly by its absorption spectrum in *Spongilla fluviatilis* and in *Hydra viridis.* Max Schultze in his *Naturgesch. Turbellarien,* (Griefswald, 1851), by solubility in alcohol, by reactions with acid and alkalis, gave reason for suspecting its presence in *Mesostomum viridatum, Vortex viridis, Stentor,* and *Hydra viridis.* These animals do not feed on Chlorophyl, they must therefore form it analytically in their tissues. Some of them present colourless varieties, and have allied species devoid of Chlorophyl. Chlorophyl might be expected in *Spongilla,* where starch had been already found. The Mollusc *Actæon viridatum* should be examined for Chlorophyl.

2nd. *Red Cruorine in Invertebrates.* I found Stokes' Red Cruorine in the non-corpusculated vascular fluid of the Annelids *Lumbricus*[1], *Eunice sanguinea,* and *Hirudo,* also diffused in the plasma of the blood of the larva of *Chironomus plumosus* (a Dipterous insect), and diffused in the plasma of the blood of *Planorbis corneus*[2]. It appears probable that some Nemertians are the lowest animals in which Red Cruorine occurs, since no Echinoderms, Cœlenterates, or Protozoa have afforded it. It is important to observe that in Vertebrates the Red Cruorine is concentrated in corpuscles, whilst in the Mollusc,

[1] Rollet has, I believe, observed this previously.

[2] It has been doubted if the red fluid spontaneously exuded by *Planorbis* is blood. It is blood, for the following reasons: it occurs in the heart; it is corpusculated; it coagulates spontaneously after exudation; it contains red cruorine.

Insect and Annelid, it is diffused in the plasma, hence the corpuscles of the blood of these animals cannot be the equivalents of the *red* corpuscles of Vertebrates.

3rd. *Green Cruorine* (*Chloro-cruorine*). The green vascular fluid of the Annelid *Siphonostoma* Rathke (*Chlorœma* of de Quatrefages) furnishes a spectrum drawn below, indicating a green body of the same nature as the Red Cruorine of Stokes. When a small quantity of the watery solution was kept a day, reduction appeared to take place as with Red Cruorine, the absorption moving towards the Red end and a new band appearing, the original spectrum being again obtained by exposure to the atmospheric oxygen. I hope to make further observations on this point. The same substance occurs in the green blood of *Sabella*.

Fig. 1.

Fig. 2.

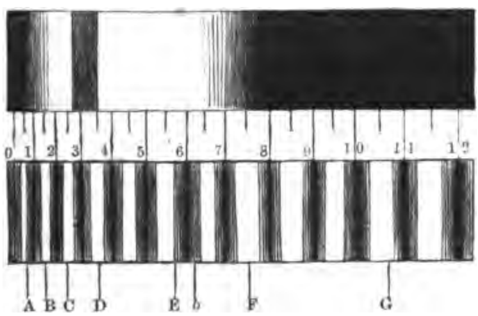


Fig. 1. **Absorption Spectrum of Chloro-cruorine.**

Fig. 2. **Sorby's Interference Scale. The centres of the lines are continued up to Fig. 1, whilst the half-spaces are marked by shorter lines. The lines and letters below Fig. 2 indicate the positions of the principal fixed lines of the solar spectrum. (See *Proc. Roy. Soc.* 1867, p. 436.)**

The spectrum written on Mr Sorby's[1] plan gives 0—$1\frac{3}{4}$, $2\frac{5}{8}$—$3\frac{1}{2}$, $6\frac{1}{2}$—7. The new absorption produced by reduction appears at about $4\frac{1}{2}$, shading more deeply towards the blue, whilst the bands in the red and orange move about half a space towards the red end.

This green body may be called Chloro-cruorine, whilst the red is termed Erythro-cruorine. There is an indication of the

[1] See *Proc. Royal Society*, No. 92, 1867.

existence of a violet and a yellow form of cruorine in certain Molluscs. Many Annelids, very nearly all Insects, Crustacea and Molluscs, have not a coloured Cruorine in their blood. Is it not probable that they possess a colourless body possessing the same oxygen-carrying properties which Stokes attributes to Red Cruorine? If so it should be classed with the red and green forms as a modification of Cruorine.

4th. *Pigmentary bodies.* The beautiful scarlet colour of *Cornatula rosacea* soluble in water and in alcohol gave no absorption *bands*, but after keeping in spirit it turned brown and gave an obscure band in the red.

The orange-red colouring matter of many Bryozoa, of *Lima hians*, of Sponges, Annelids and Crustacea (*Alpheus ruber*, eggs of *Maia squinado*), was extracted with ether; it appeared to be the same body in all, but gave no bands in the spectrum. Other yellow, green and purple pigments, soluble in ether, were examined with the same negative results, from the scales of fish, birds' feathers, the bile, &c. The absence of absorption bands in the spectra of most animal pigments may be connected with other optical properties which as *fats* most of them possess.

5th. *Phosphorescent light.* I examined the light emitted by the phosphorescent mucus secreted by glands at the base of the large primules in the Annelid *Chætopterus insignis* Baird. The light gave a diffused spectrum from about line 5 to line 10 on Sorby's scale.

NOTES ON THE OSTEOLOGY OF THE INSECTIVORA.

By St George Mivart, F.L.S.; *Lecturer on Comparative Anatomy at St Mary's Hospital.*

Continued from page 312.

Urotrichus[1]. This genus presents marked differences from the last two very talpoid genera, though still having a great number of characters in common with the mole. It is represented in the British Museum by a single skeleton, the skull of which is a little injured, and the skin of the palate unremoved. It agrees, as far as I have been able to observe, with the description above given of our second type (*Talpa*), except in the following particulars.

Urotrichus. Scale, 2 natural size.

There is a very small, but distinctly marked, sagittal ridge, and there are also small but distinct pterygoid fossæ; also the pterygoid region is not so inflated. The semicircular canals do not appear to be so salient in the cranial cavity, and the pterotic is much smaller.

Urotrichus. Scale, 2 natural size.

The mandible is shorter in proportion to its height, and its inferior margin is rather less undulating. The inside of the coronoid process (which rises higher above the condyle and is less truncated) is more strongly concave. The fissure which in *Talpa* borders the epiotic is here represented by a mere suture. The spheno-palatine foramen is placed very far forwards in a fossa situated between the roof of the palate and the cranium. The lachrymal foramen is not upon the cheek, but immediately above the middle of the infra-orbital foramen.

The dentition is probably

$$\text{I. } \frac{2-2}{1-1},\ \text{C. } \frac{1-1}{1-1},\ \text{P.M. } \frac{4-4}{3-3};\ \text{M. } \frac{3-3}{3-3} = \frac{20}{16} = 36.$$

showing a remarkable approximation to Sorex in the number of the lower incisors. As to the number of superior incisors, that of course

[1] For the skeleton of this genus see Temm. *Faun. Japon.* I. tab. 4.

depends on the position of the premaxillary suture, which I have been unable to find any traces of. The 1st upper incisor is very large, in contact with its fellow of the opposite side, and much like that of *Scalops*. It is the most vertically extended tooth of the upper jaw. The 2nd upper incisor is about half the size of the preceding; it is simple and conical. The canine (if it is a canine) is the smallest tooth in the upper jaw, and is exceedingly minute. The next three teeth are simple conical premolars, gradually increasing in size from before backwards.

Grinding surface of left dental series of upper jaw of *Urotrichus*. Scale, 2 natural size.

The last premolar is much larger, and quite like the corresponding one of *Talpa*, except that it is slightly more produced inwards, and in so far resembles *Scalops* and approximates to *Sorex*. The 1st and 3rd upper true molars closely resemble those of *Talpa;* but the 2nd is more complex, presenting two inner cusps, and besides these a third prominence from the internal cingulum.

In the lower jaw the incisor is long, conical, and pointed. It is strongly grooved internally, in a vertical direction, and diverges as it ascends from its fellow of the opposite side. The lower canine is

Grinding surface of right dental series of lower jaw of *Urotrichus*. Scale, 2 natural size.

small, simple, and somewhat procumbent. The 1st premolar closely resembles the canine, the 2nd is much smaller, and is the smallest tooth in the mandible. The 3rd and last premolar is larger, and closely resembles its homologue in *Sorex*. The lower true molars are quite like those of *Talpa*.

As regards the rest of the skeleton, there are 13 dorsal, 7 lumbar, and 5 sacral vertebræ. The manubrium is much smaller, though still strongly keeled. The clavicles are stout, though not nearly so much so as in *Talpa;* they still however articulate with the humeri, which are much more cylindrical, though still very strongly ridged. There is, I believe, no sickle-like carpal bone; but the form of the ultimate phalanges of the manus I could not ascertain. The scapula is like that of the mole, except that it has a distinct metacromion process.

MYOGALE[1]. Unfortunately no skeleton or skull of *M. muscovita* exists, to my knowledge, in this country; but a skeleton and a separate skull of *M. pyrenaica* are preserved in the national collection.

[1] The skeleton of *M. pyrenaica* is represented by De Blainville, also the skull and dentition, *loc. cit.* Pl. II. V. and IX.

The near resemblance of this form to *Talpa* is manifest; and as regards the points mentioned in describing the last-named genus, the only differences I have been able to detect are as follows: The interorbital, lateral constriction of the cranium is more marked, and consequently the temporal fossæ are larger. There are hardly any traces of cranial ridges, except the lateral parts of the lambdoidal ridge. The palate extends back decidedly beyond the last molar; its posterior margin is thickened, but it has no defects of ossification. There are well developed pterygoid fossæ, and the pterygoid region is not inflated. The meso-pterygoid fossa scarcely, if at all, narrows posteriorly. The glenoid surface is rather larger. The premaxilla is probably more developed than in *Talpa*, and the supra-occipital is even rather more so than in that genus. External to the exoccipital is a considerable vacuity in the cranial parietes. The pterotic is no doubt large; but I have not observed it distinct as in *Talpa*. There are no marked depressions beneath the basi-occipital; but the basi-sphenoid is very thin, there being, in one specimen, even a small defect of ossification in the floor of the *sella turcica*. The coronoid process of the mandible is much higher than in *Talpa*, reaching as high as the summit of the cranium. It is also more inclined forwards, and its apex is not at all truncated. The large rounded opening before mentioned appears to supply the place of the aperture which borders the epiotic in *Talpa*. A posterior palatine foramen opens on each side a little in front of the anterior end of the posterior fourth of the palate. The anterior palatine foramina are exceedingly and remarkably large. The spheno-palatine foramen is situated far forwards as in *Scalops*. The infra-orbital foramen is about as large as in *Talpa*, but the spiculum above it is very much larger. The lachrymal foramen is exceedingly small, and opens (above the middle of the infra-orbital foramen) at the anterior side of the upper end of the lamella, bounding posteriorly the infra-orbital foramen. The mental foramina open only a little in front of the middle of the horizontal ramus of the mandible.

The dentition seems to be

$$\text{I.}\ \frac{2-2}{2-2},\ \text{C.}\ \frac{1-1}{1-1},\ \text{P.M.}\ \frac{5-5}{5-5},\ \text{M.}\ \frac{3-3}{3-3}=\frac{22}{22}=44.$$

Yet there appear traces of the premaxillary suture behind the first upper tooth of the British Museum specimen[1]. The first tooth in the upper jaw is much larger and more vertically extended than is any

[1] Also in F. Cuvier's *Dents des Mammifères*, Pl. 21. The above formula expresses the views of Professor Peters, kindly communicated to me in a letter in which he says, "I find in a young skull of *M. moschata* the 1st and 2nd upper teeth are entirely and the 3rd *partly* in the intermaxillary bone." Possibly then the true reading may be

$$\text{I.}\ \frac{3-3}{3-3},\quad \text{C.}\ \frac{1-1}{1-1},\quad \text{P.M.}\ \frac{4-4}{4-4},\quad \text{M.}\ \frac{3-3}{3-3},$$

which would harmonize much better with the other genera of Insectivora than does the formula provisionally given in the text.

other tooth in the skull. Its crown is triangular, it is in contact with its fellow of the opposite side, and predominates more than does the first incisor of any other form yet reviewed, except perhaps that of *Sorex*, from which however it differs much in form. The two next teeth (which are close together, but separated from the first by a considerable interval) are exceedingly small teeth, and they are simple and conical. The next is larger; it has two roots, but a simple conical crown. The three next are similar in form, and do not differ much in size, though the first of them is rather smaller than either its anterior or posterior neighbour. The next, which is the last upper premolar, is like that of *Scalops*, and rather more extended inwardly than in *Talpa*. The true molars are very like those of *Urotrichus*. In the lower jaw the 1st tooth is much smaller than the 2nd, but much larger than the 3rd. The 4th, and the four following teeth, are simple and conical, gradually increasing in size from before backwards; but the last two have a very small additional postero-external cusp. The lower true molars are quite like those of *Talpa*.

As regards the rest of the skeleton there are 13 or 14 dorsal, 5 or 6 lumbar, 5 sacral, and many caudal vertebræ. The spinous process of the axis is the only cervical one, and that is small. The neural arches are mere filaments. All the dorsal vertebræ, except the first 2, have small spines. The other vertebral processes of the trunk appear to be as in *Talpa*, except that the lumbar metapophyses are rather more developed. The manubrium is small, and has but a very slight keel. The clavicle is elongated but stout (much as in *Urotrichus*), and scarcely, if at all, articulates with the humerus, which is elongated (though much ridged), and has a large supracondyloid perforation. There is an os intermedium, but no sickle-shaped ossicle. The ultimate phalanges are not longer than the proximal ones. They are pointed, and antero-posteriorly directed dorsal grooves alone indicate a tendency to bifurcation. The scapula has a large metacromion process. The third trochanter of the femur is more distinct, and the pes is very much longer, both absolutely and compared to the manus, in which *Mygale* differs not only from *Talpa*, but from *Condylures*, *Scalops*, and *Urotrichus* also.

As regards *M. muscovita*, Dr Brandt's[1] description shows that it closely agrees with *M. pyrenaica* in the form of its skeleton. It has 13 dorsal and 6 lumbar vertebræ, and the palatine plate of each maxillary bone has a considerable oblong opening. It has openings in the occiput as in *M. pyrenaica*[2].

[1] *Archiv für Naturgeschichte*, 1836. Vol. I. pp. 180—182.

[2] Since the above was in type, I have had the opportunity of seeing, at Paris, the skeleton of *M. muscovita*. The skull has a well developed sagittal ridge which, at its junction with the lambdoidal crest, develops a peculiar prominence. The openings external to the supra-occipital are very large, but the spiculum above the infra-orbital foramen is slender. The coronoid process of the mandible is not inclined forwards or truncated, though it rises nearly to the summit of the cranium. There is a minute spinous process to the sixth cervical ver-

ERICULUS. No skull of this Madagascar form as yet exists in the national collection, but it is well represented by Isid. Geoff. St Hilaire[1], and by De Blainville[2], and, as I have already said, the kindness of Professor Newton of Cambridge has enabled me to examine the cranial characters of the genus as fully as is possible without mutilation of the skull.

As has been generally recognised *Ericulus* is closely allied to *Centetes*, and indeed corresponds with the description above given of that genus, except in the following points. The skull is very much smaller, smaller even than in *Erinaceus;* and, as might almost be anticipated, there is no marked sagittal ridge. The palate projects backwards much beyond the last molars, but its posterior margin is not thickened. The meso-pterygoid fossa narrows very much as it proceeds from before backwards; and the process of the squamosal, the under surface of which articulates with the mandible, is separated by a deep notch from the mastoidal process, so that, together with the par-occipital process, there are here three distinct processes on each side. The premaxillæ do not nearly reach the frontals, and the latter form a larger portion of the cranial roof. The posterior margin of the mandible, between the angle and condyle, is more concave. No second prominence, anterior to the angle, is developed from the inferior border of the mandible. There is no glenoid foramen, but (as sometimes in *Erinaceus*) a conspicuous opening just beneath the foramen ovale leads into the tympanic cavity. The posterior palatine foramina are smaller than in *Centetes*, but there are numerous minute perforations scattered over the palate. The spheno-palatine foramen is rather nearer to the foramen rotundum than in the last-named genus, though the approximation is not nearly so great as in *Erinaceus.* The dental formula appears to be

$$\text{I. } \frac{2-2}{2-2},\ \text{C. } \frac{1-1}{1-1},\ \text{P.M. } \frac{3-3}{3-3},\ \text{M. } \frac{3-3}{3-3} = \frac{18}{18} = 36.$$

In the upper jaw, the incisors are rather larger as compared to the other teeth, than in *Centetes*, and the 2nd is not so much curved. The canine is not caniniform, but is like the 2nd incisor, only much larger, and with two roots. The 1st premolar is larger and more complex than in *Centetes*, and much resembles the 2nd premolar of that genus, except that it is relatively less vertically extended. The 2nd premolar is more like the true molars than in *Centetes*. It somewhat resembles the 2nd premolar of that genus, but the principal cusp is less developed, while the postero-internal one is very much more so, and no less than three small cusps are developed from

tebra. The clavicle does articulate with the humerus, and the ultimate phalanges of the manus are longer than the proximal ones. The metacromion process of the scapula is very long, and the posterior end of the spine of the scapula sends out a similarly directed process. The third trochanter is very large and the pes exceedingly elongated.

[1] *Magasin de Zoologie*, 1839. *Mammifères*, Pl. IV.

[2] *Loc. cit.* Pl. VI. and X.

an external cingulum. The 3rd premolar and first two molars are as in *Centetes*. The 3rd molar, is smaller as compared to the others, than in the last-named genus. In the lower jaw the 1st incisor is a little smaller than the 2nd, and the 2nd than the canine. The crowns of the two last-mentioned teeth each consist of a large anterior part, which is notched, and a small posterior portion, so that each has in fact three lobes, the first however being very minute. The lower canine is thus very different from its homologue in *Centetes*. Its apex also is not received into an excavation of the upper jaw. The 1st premolar is like the canine, but smaller, and relatively more extended antero-posteriorly. The 2nd premolar is very unlike that of *Centetes*. It consists of a large anterior portion, which is tricuspid, and of a small, low, transverse, posterior ridge. The more posterior teeth closely resemble their correspondents in *Centetes*.

As regards the rest of the skeleton of *Ericulus*, the vertebral column, scapula, clavicle, pelvis and femur, are entirely unknown to me, but the other bones present the following characters: the humerus has a supra-condyloid foramen, but no inter-condyloid perforation. The radius and ulna are complete and distinct. The carpus has an os intermedium, but the scaphoid and semilunar bones are separate. The tibia and fibula are both complete their whole length not anchylosing together inferiorly. The metatarsus is short.

ECHINOPS. This small genus, also from Madagascar, is only known from my late lamented friend Mr Martin's description[1], and from the skeleton (minus the cranium and bones of the extremities) of the individual described by him, which is now preserved in the Osteological collection of the British Museum. It is, as Dr Peters has announced[2], nearly allied to *Centetes*, and the only differences I have been able to detect are these. The skull is shorter in proportion to its breadth, as is also the palate, the posterior margin of which is not thickened. There is no sagittal ridge. The meso-pterygoid fossa contracts in width *very* much from before backwards, but (judging from the figure) it ends in no hemispherical excavation. As in *Ericulus*, there are three processes in each side of the posterior part of the skull. The premaxilla does not join the frontal; the mandible is like that of *Ericulus*, except that the coronoid process is higher and more pointed. As to the foramina all that can be said is[3], that the posterior palatine ones appear to be smaller than in *Centetes*, the infra-orbital canal to be smaller and somewhat longer, so that it opens anteriorly, decidedly in front of the lachrymal foramen. The dental formula is

$$\text{I. } \frac{2-2}{2-2},\ \text{C. } \frac{1-1}{1-1},\ \text{P. M. } \frac{2-2}{2-2},\ \text{M. } \frac{3-3}{3-3} = \frac{16}{16} = 32.$$

[1] *Trans. Zool. Soc.* Vol. II. p. 249, Pl. 46.

[2] *Monatsber. Akad. W. Berlin*, 1865, p. 286.

[3] No ali-sphenoid canal is represented in Mr Martin's plate, but I strongly suspect that it exists.

The 1st upper incisor predominates more over the 2nd than in *Centetes* or *Ericulus*. The specimen figured had the teeth much worn, but the incisors probably resemble in form those of *Ericulus*. The canine also, except that it may be more vertically extended. The upper premolars appear to be very much like the first two of *Ericulus*, and the three upper molars are like the molars of that genus.

In the lower jaw the teeth appear closely to resemble those of *Ericulus*, the 2nd premolar of the latter being removed.

As regards the rest of the skeleton, I find 16 (if not 17) dorsal, 6 (perhaps 5) lumbar, and 3 sacral, and but few caudal, vertebræ. The spine of the axis vertebra is mutilated, but seems to have been only of moderate size. The dorsal spines are not more elongated than in *Erinaceus*, but the lumbar ones agree with those of *Centetes* in being more antero-posteriorly extended than in the former genus. The lumbar transverse processes are rather smaller than in *Centetes*, the hyperapophyses, on the other hand, are more marked. The scapula has its infra-spinous fossa rather smaller, as compared to the supra-spinous one, than in *Centetes;* and the free margin of the spine is less undulating. The humerus is of about the same length as the scapula. The fore-arm is unknown to me, also the tibia, fibula, and pes; but the femur closely resembles that of *Centetes*.

SOLENODON. This West Indian genus has been first described by Brandt[1], more recently by F. Poey[2], and lastly by Dr Peters[3]. The last-named author refers it to his sub-family *Centetina*, justly remarking its many striking affinities to *Centetes*.

This genus is not represented by either skeleton or skull in the British Museum or in that of the Royal College of Surgeons; but the great kindness of Professor Peters has (as I said in the commencement of this article) enabled me to examine the original skull (described and figured by him) of *S. cubanus*. I find that it entirely corresponds with *Centetes* in all the points above enumerated in the description before given of my sixth type except as regards the following details:—When viewed above, the cranium is much less cylindrical, there being a marked interorbital constriction, and the face is relatively narrower. The posterior end of the skull appears less truncated on account of the very strong backward projection of the large lambdoidal ridge. Anteriorly the premaxilla projects much forwards at the side of the anterior nares, giving a peculiar contour to that part. There is a slight ridge at the front of the orbit running upwards immediately before and above the lachrymal foramen, and resembling much that of *Erinaceus*. The upper end of this ridge is continued very faintly backwards and inwards till it

[1] *Mém. de Petersburgh*. 1833. Sixth Series. II. Tab. 1 and 2. Copied by Dr Blainville. *loc. cit.* Pl. V. and IX., and by Owen, *loc. cit.* Pl. III. fig. 1.

[2] *Memorias sobra la historia natural de la Isla de Cuba*. I. Habana, 1851, p. 23.

[3] *Abhandlungen der K. Akad. der Wissenschaften zu Berlin*. 1864. Vol. I. Pls. I. to III.

meets its fellow of the opposite side, the two uniting to form a slightly developed sagittal ridge. There is scarcely any concavity at the side of the muzzle, but a marked one on the summit of the cranium between the orbits. There is a rather small defect of ossification at the middle of the palate towards its hinder part, in *S. cubanus*, but, apparently, not in *S. paradoxus*. There are no pterygoid fossæ whatever, and the meso-pterygoid one (which slightly expands laterally as it proceeds backwards) ends in no hemispherical or other excavation, but its roof is continuous with the posterior part of the under surface of the *basis cranii*. There are no basi-sphenoidal processes, and there is no paroccipital process. The rudimentary mastoidal one is found with the glenoidal projection of the squamosal, so that there is but one lateral projecting process here on each side—in *S. cubanus*, at least. The glenoid surface is smaller and more strongly concave from behind inwards to before outwards, an obliquely situated, depending process acting as both an anteglenoidal and postglenoidal one. This process is larger than in *Centetes*, and approximates somewhat to that of *Sorex*. The presphenoid does not appear to be swollen out by a large internal cavity. The premaxilla is rather large, but does not meet the anterior prolongation of the frontal. The anterior rudiment of the zygoma is strongly concave in front, externally to the infra-orbital foramen. The mastoidal portion of the epiotic does not join with an occipital prominence to form a paroccipital process, but nevertheless it bifurcates below. Part of the external surface of the ascending ramus is deeply concave, and the condyle is much extended transversely. The prominence which in *Centetes* is developed from the inferior margin of the mandible in front of the angle has here become a sharp and strongly-marked process. There is a double precondyloid foramen on each side. Several small venous foramina open on the outside of the hinder part of the skull, and there is a very large postglenoid foramen. The small optic foramen is not hidden by the alisphenoidal lamella. Three orbital foramina open just above and in front of the optic one. The moderate sized posterior palatine foramina open close to but distinct from the spheno-palatine foramen. The lachrymal foramen opens just at the anterior margin of the orbit. The dental foramina (on the side in which there are two) are not wide apart on the outer side of the mandible.

The dental formula is apparently

$$\text{I. } \frac{2-2}{2-2}, \quad \text{C. } \frac{1-1}{1-1}, \quad \text{P.M. } \frac{4-4}{4-4}, \quad \text{M. } \frac{3-3}{3-3} = \frac{20}{20} = 40.$$

The third upper tooth on each side has its crown in front of the premaxillary suture, but Professor Peters calls attention[1] to the fact that its root extends into the maxilla, and the predominance of its maxillary relations is well seen when the palate is looked at.

The 1st upper incisor is the most vertically extended tooth of the upper jaw, like that of *Mygale*, and, as Dr Peters remarks[2], it has

[1] *Loc. cit.* p. 7. [2] *Loc. cit.*

considerable resemblance to that of *Scalops*. The inner border of the crown of the tooth develops a small process which is in contact with the similar process of the first incisor of the opposite side. The 2nd incisor is a simple conical tooth with a rudimentary talon. It is very much smaller than the 1st incisor, from which it is separated by a considerable interspace, where is a depression for the reception of the apex of the 2nd inferior incisor. The canine is similar in form to the second incisor, but is smaller; it being the smallest tooth in the upper jaw. It is placed close to the second incisor. The 1st premolar is separated by a considerable interval from the canine. It is a large stout, rounded, obtusely pointed, conical tooth with two roots. The 2nd premolar is similar, except that it is smaller and especially shorter. It is separated by a slight interval from the first premolar. The 3rd premolar very much resembles the second premolar of *Centetes*, but is considerably smaller, and does not predominate, in vertical extent, over the tooth next behind. The 4th premolar is quite like the third of *Centetes*, except that the principal cusp is more vertically extended. The true molars are quite like those *Centetes*, except they decrease in size from the first to the third in a marked degree. In the lower jaw the teeth are close to each other, and the incisors (as Dr Peters remarks[1]) resembles those of *Scalops aquaticus*. The 1st incisor is exceedingly small, indeed the smallest tooth of the entire dentition. Its crown slightly broadens towards its summit which is notched.

The 2nd incisor is exceedingly large, pointed and conical, and has a wonderfully deep groove on its inner side. The canine is a small obtusely pointed tooth, which has a slight anterior production and also a small posterior talon. The 1st premolar is similar to the canine but larger, and the anterior and posterior processes are relatively less marked. The 2nd premolar is a simple, rounded, conical, obtusely pointed tooth. The 3rd premolar is like the second in all respects except it develops a slight postero-internal process at the base of its crown. The 4th (and last) premolar would be very like the 3rd (and last) premolar of *Centetes* if the antero-internal cusp of the latter were suppressed. The true molars are quite like those of *Centetes*, except that the basal posterior portion of the last is more developed. As regards the rest of the skeleton there are 15 dorsal, 4 lumbar, 5 sacral, and many caudal vertebræ.

All the other skeletal characters before attributed to *Centetes* exist certainly in *Solenodon* with the exception of the undulating outline of the margin of the spine of the scapula and the excavation at the lower end of the front of the femur, which may exist but are not figured.

POTOMOGALE. The osteology of this highly interesting African Insectivore is only known to me by the skull so kindly sent to me by Professor Allman, and by his description[2], and that of Professor

[1] *Loc. cit.* p. 9.
[2] *Trans. Zool. Soc.* Vol. VI. p. 1, Pl. I. and II.

Barboza du Bocage[1]. On comparing the cranium with the crania of other genera of the order, there can, I think, be little doubt but that on the whole it more resembles *Centetes* than any other form, though it has also a certain superficial resemblance to *Sorex;* and comparing it with the first-named genus, I find that the skull is much less cylindrical, the cranium proper narrowing considerably and continuously forwards from the interglenoidal region to the cribriform plate. The muzzle, as in *Solenodon*, is much narrower than the cranium proper, and its lateral walls are nearly parallel. There is no trace of a post-orbital process. The skull is not truncated at either end, for anteriorily the nares slope backwards as in *Centetes*, while posteriorly the occiput slopes strongly forwards. There is no ridge or process at the front of the orbit, but a very slight sagittal ridge and a considerable lambdoidal one, which (as in *Ericulus* and *Solenodon*) is most marked at the sides. The temporal fossa is large, and there is a deep concavity at the side of the muzzle immediately in front of the infra-orbital foramen, but none on the summit of the cranium. The palate is long and narrow, of nearly equal width throughout, but narrowing a little from behind forwards. It is also slightly concave from behind forwards; but there is no median antero-posterior ridge, nor any defect of ossification, though there are many small foramina which perforate the palatine plate of the maxillæ but not of that of the palatine bones. Indeed the extent to which the maxillæ are perforated is very remarkable. The posterior margin of the palate is not thickened, but is narrow and concave backwards. There is no trace of a pterygoid fossa, but the meso-pterygoid one is deep, narrow, and becomes rapidly narrower still from before backwards, its lateral walls tending inwards remarkably. It does not end posteriorly in a hemispherical or other excavation, but its roof is continuous with the rest of the basis cranii, though a slight median depression marks the under surface of the basi-sphenoid. The basi-occipital is large, and its under surface ascends from before backwards, as in so many other aquatic mammals. The auditory bullæ appear to be completed by large basi-sphenoidal processes. The foramen magnum is very large, especially in width, and looks directly backwards, or even slightly upwards. There are well-marked, though rather small, paroccipital processes which are peculiar, because, as Professor Allman remarks[2], they extend "horizontally backwards." There is only a rudimentary mastoid process which (as in *Centetes* and *Solenodon*) is closely united to the glenoid process of the squamosal; thus there are here only two distinct processes on each side. The mastoid contributes but very slightly to the formation of the paroccipital process. The glenoid surface is made transversely concave by a strongly projecting ento-glenoid process, which is placed obliquely so as to serve also as a post-glenoid process. Its development closely re-

[1] Noticia acerca dos caractéres e affinidades naturaes de uno novo genero de Mammiferos insectivoros da Africa occidental, Bayonia velox, 1ª Classe da Academia de 27 d'Abril, 1865. Lisboa.

[2] *Loc. cit.* p. 10.

sembles that of the same part in *Centetes*. The rhinencephalic chamber is much smaller than in *Erinaceus*, but the pré- and basisphenoids are narrow and not swollen out by internal cavities. The premaxilla is large, but does not meet the anterior prolongation of the frontal. The nasals unite early together, but do not extend backwards so far as do the maxillæ. The parietals form a very large part of the cranial roof. The zygoma is wanting, only a small process extending backwards and outwards above the last molar. The squamosal is all but entirely excluded from the cranial cavity, but the mastoidal region of the periotic is largely visible on the exterior of the skull. The mandible has its ascending ramus only slightly concave externally; its posterior margin, between the condyle and the angle, is short but deeply concave. The horizontal ramus is not constricted behind the last molar, but the inside of the ascending ramus above the mylohyoid ridge is markedly concave. The angle is sharp and elongated. The condyle is almost as much transversely extended as in *Erinaceus*, though not so much so as in *Solenodon;* and the broad coronoid process ascends much above it when compared to the distance between the condyle and the angle, which latter is small and much flattened from above downwards. There is a distinct indication of the second process which, in *Solenodon*, projects from the inferior margin of the mandible in front of the angle.

The precondyloid foramen is enormous[1]; and the jugular foramen is continued forwards as a narrow fissure, separating the periotic from the basi-occipital and basi-sphenoid. I have not found a distinct carotid foramen, though small foramina perforate the base of the basi-sphenoidal tympanic processes. A venous foramen opens near the margin of the squamosal: there is also a very small glenoid foramen. The Eustachian tube opens just beneath the foramen ovale. One large opening represents both the foramen rotundum and the sphenoidal fissure. The optic foramen is very small, and, with the just mentioned opening, is hidden by the alisphenoidal lamella. The optic nerve traverses no long bony canal, as in *Erinaceus*. There is a small but distinct sub-optic foramen communicating with its fellow of the opposite side, and not with the cranial cavity. Immediately above this is an orbital foramen. A conspicuous alisphenoidal canal opens just in front of the foramen ovale; but there is no external alisphenoidal canal. A very small posterior palatine foramen opens below, near the posterior end of the palate. Above, it opens just behind the spheno-palatine foramen, which is situated rather far forwards, and widely separated from the opening representing the foramen rotundum. The anterior palatine foramina (one on each side) are large, but not so much so, relatively, as in *Mygale*. The infra-orbital foramen is single and very large, and is the anterior opening of an *extremely* short canal. There is no lachrymal foramen.

[1] This large basi-occipital perforation, the sloping upwards behind of that bone and the forward inclination of the supra-occipital, are all characters more or less commonly present in aquatic beasts.

Two mental foramina open at some distance from each other outside the horizontal ramus of the mandible; the more anterior being between (and below) the canine and the first premolar; the more posterior below the first true molar. The teeth in the specimen examined by me are 36 in number, 9 on each side of each jaw. Professor Allman considers that the tooth which I prefer to call canine should rather be considered a premolar, on account of its complete similarity in form to the undoubted premolar behind it. But the two incisors have also very nearly the same shape, and unless a tooth developed in the maxilla but close behind the premaxillary suture be in all cases called canine (whatever its shape), great uncertainty and inconvenience would result in dental nomenclature. In the fully adult specimen however, described and figured by Professor Barboza du Bocage, the number of teeth is 10 on each side of each jaw; and a close inspection of the Edinburgh specimen shows that another grinder is probably yet enclosed in its alveolus on each side of the mandible[1], while the posterior end of each maxilla has apparently been fractured and the last existing molar has not come fully into place[2].

In Professor du Bocage's plate (fig. 2) the premaxillary suture is represented as separating the second tooth from the third; but in the Edinburgh specimen it is very distinct, and (not only at the side of the face, but also on the palate,) clearly separates the third tooth from the fourth; the third tooth being evidently implanted in the premaxilla exclusively; thus the dental formula for this appears to me to be

$$\text{I. } \frac{3-3}{3-3},\ \text{C. } \frac{1-1}{1-1},\ \text{P.M. } \frac{3-3}{3-3},\ \text{M. } \frac{3-3}{3-3} = \frac{20}{20} = 40.$$

The 1st incisor is very large, being the most vertically extended tooth of the upper jaw. It has considerable resemblance to that of *Solenodon*, even developing a slight process on its inner side, though this is situated higher up, and is very much less marked than in the last-mentioned genus. The 2nd upper incisor is, as Professor Allman observes[3], "separated from the first by a narrow space, which receives the second incisor of the lower jaw when the mouth is closed; it is triangular, compressed, with a sharp anterior and a sharp posterior edge—the anterior edge being convex, and the posterior slightly concave. The third incisor is of the same form as the second, but a little smaller. The incisors are each implanted by a single fang." The canine and 1st upper premolar are very similar in shape to the posterior incisors, but rather more antero-posteriorly

[1] On my returning the skull to Prof. Allman, he discovered the missing tooth: "it was a mere rudiment still in its capsule," as he was kind enough to inform me. A notice of this circumstance was communicated by him to the Zoological Society, on March 14, 1867.

[2] The imperfectly united condition of the epiphyses of the limb-bones seems to be indicated in Plate II. of Professor Allman's Memoir.

[3] *Loc. cit.* p. 7.

extended, while each has two fangs. The 2nd upper premolar is very much like the second of *Centetes*. The 3rd premolar and the first two upper molars are very much alike and very interesting, inasmuch as they present as it were a transitional structure between molars (such as those of *Talpa*) with two triangular prisms each, and molars (as those of *Centetes* and *Ericulus*) which have each only one such prism[1]. For each of these teeth have three or four very small cusps developed from the external cingulum, a very large cusp arising from the internal cingulum, and two median cusps, from each of which two slightly marked diverging ridges proceed outwards to the external cingulum, forming two very narrow triangular prisms so close together that a little more approximation would reduce them to a single prism, such as exists in *Cetetes* and *Solenodon*. These three teeth successively increase somewhat in transverse extent from before backwards. The third and last molar is absent in the specimen examined by me; but from Professor du Bocage's figure it is similar to, but somewhat smaller and less developed than, the other molars.

In the lower jaw the 1st incisor is very small (the smallest tooth in the mandible), its crown is expanded laterally however, and inclines to and meets its fellow of the opposite side. The 2nd incisor is large and canine-like, like that of *Solenodon*. It is somewhat grooved behind and also on the inner side, and presents a slight process at its base behind, and another, also towards its base, on its inner margin. The 3rd incisor is small, simple, procumbent, with a slight posterior process at its base. The canine is of similar form, except that it is less procumbent; it is also larger, and more vertically extended. The 1st premolar is similar as to its crown, though smaller. It differs from the more anterior teeth of the mandible, in that it is implanted by two fangs. The 2nd premolar is larger, with a small tubercle at its base in front, and another one behind; the posterior cutting edge also develops a small cusp. The 3rd premolar is very like that of *Centetes*, and consists of a triangular prism (with an angle turned outwards), and a posterior basilar process. The first two molars are of similar form; and all three have the posterior basilar process more developed than in the corresponding teeth of *Solenodon* or *Centetes*. The 3rd and last lower molar appears, from Professor du Bocage's figures, to be of the same shape as the preceding molars, but rather larger in size. In the greater size of the posterior basilar process of the lower molars we again see an approximation (similar to that existing in the upper molars) to that type of dentition which presents us (as in *Talpa*) with two triangular prisms to each lower molar.

As regards the rest of the skeleton, there are, according to Professor Allman[2], 16 dorsal and 5 lumbar, 3 sacral and many caudal vertebræ. The spinous process of the axis is exceedingly large; and the other cervical vertebræ have all more or less elongated spinous

[1] See below, woodcut on page 188. [2] *Loc. cit.* p. 8.

processes. The cervical transverse processes are not much expanded antero-posteriorly. The 3rd, 4th, 5th, and 6th cervical vertebræ have hypapophysial processes. The dorsal spines are elongated, and those of the lumbar region are much antero-posteriorly extended. The metapophyses, anapophyses and transverse processes are small; but there are well marked hyperapophyses[1] on the two last dorsal and the first four lumbar vertebræ. Small hypapophyses are developed beneath the first four dorsals, and the caudal vertebræ are provided with large chevron bones. The manubrium is of moderate size and not keeled. The clavicle, by a most remarkable exception amongst Insectivora, is entirely absent. Both supra- and infra-spinatus fossæ are well developed in the scapula, which has no metacromion process, and the acromion is very slender. The humerus is decidedly longer than the scapula, and its lower end has neither olecranal nor supra-condyloid perforation. The great tuberosity is exceedingly elongated[2]. The radius and ulna are complete and distinct. The carpus has eight bones; and these Professor Allman has been kind enough to inform me, are the usual ones, there being no intermedium, and the scaphoides and semilunare being separate. The pelvis is wide with a very small pubic symphysis. The ilium is not markedly concave either within or without. The femur has but a slight ectogluteal ridge: whether the inferior, anterior depression exists as in *Centetes*, I cannot say. "The tibia and fibula are confluent with one another for the lower third of their length[3]." The metatarsus is not much elongated.

CHRYSOCHLORIS[4]. This African genus presents us with remarkable characters different from any we have yet met with. It has usually however been associated with *Talpa*, but if compared with that genus it will be seen to differ from it in many respects, and strikingly in the general form of the cranium. Indeed the rapidity with which the skull narrows from behind forwards is greater than in any other Insectivore, and is most nearly approached by *Macroscelides proboscidens*. The vertical extent of the cranium is also much greater in proportion to its length than in *Talpa*. The greatest breadth of the skull too, unlike that of the last-named genus, is situated between the posterior roots of the zygomata, and these, instead of being slender, are exceedingly strong and much vertically extended arches. The

[1] See *loc. cit.* Pl. II.

[2] "A strong pyramidal projection, by which the axis of the shaft is continued for about $\frac{3}{16}$ths of an inch beyond the head." Allman, *loc. cit.* p. 12. "Quanto ao humerus, esse distingue se muito bem do humerus do *Solenodon*, e de todos os insectivoros, por uma grande apophyse vertical e conica que occupa precisamente o logar da grande tuberosida. Esta apophyse, que se encontra egualmente na extremidade superior do humerus d'outros mammiferos não claviculados, os ruminantes, tornaria por si só impossi vel a juncção do clavicula à crista da omoplata." *Barboza du Bocage*, *l. c.* p. 12.

[3] *Loc. cit.* p. 13.

[4] The skull, dentition and various parts of the skeleton of this genus are represented by De Blainville, *loc. cit.* Pls. V. VII. VIII. and IX. For the dentition also, see F. Cuvier, *loc. cit.* No. XVIII., and Owen, *loc. cit.* Pl. CX. fig. 1.

orbits however are incomplete, and there is not even a trace of a post-orbital process, though the skull is slightly constricted laterally, behind the orbits. The occiput is very large, as in *Talpa*, but it does not slope forwards as in that genus. The anterior nares are very remarkable, the premaxilla on each side being produced forwards in a very singular way, resembling that already noticed in *Solenodon*, but greater in degree. The processes are so twisted that the flattened surfaces of each look rather upwards and downwards than inwards and outwards; so that when the extremity of the muzzle is looked at from above, it has somewhat the appearance of a miniature representation of the same part in the skull of the *Ornithorhynchus*. There is no sagittal ridge, but a lambdoidal one traverses the summit of the cranium and becomes continuous on each side with the zygoma, so that between the posterior end of this arch and the proper cranial wall a remarkable fossa is formed. There is no ridge or process in front of the orbit. The temporal fossa is rather large but in *C. capensis* is encroached upon by the well-known[1] bony vesicle. The palate is short and wide, and widest between the last premolars. It is rather strongly concave antero-posteriorly, but has no longitudinal median ridge. There are no defects of ossification in the palate, nor is there any thickening of, or median projection from, its posterior margin, which is either some little distance behind the last molars, or almost on a line with them. There are no pterygoid fossæ, and the well-defined meso-pterygoid fossa narrows but very slightly backwards and ends in no excavation. The pterygoid region itself is not inflated; though the vesicular enlargement behind it on each side is more prominent and sharply marked than in *Talpa*. The foramen magnum is large, but looks rather more backwards than in *Talpa*. There are no paroccipital or mastoidal projections. The glenoid surface is triangular and very small; it is situated quite behind the foramen ovale and above the external opening of the auditory meatus. The cranial wall bounds it both internally and behind. The cribriform plate is very large, but the pre- and basi-sphenoids project but little into the cranial cavity. The periotic is not nearly so salient inwards as in *Talpa*. The cranial bones anchylose together very early, but Professor Peters[2] has detected the limits of the premaxilla, which is of considerable size. There is no distinctly marked pterotic or any lateral occipital fissure.

The mandible is very peculiar, the upper part of the ascending ramus having the appearance of having been sharply cut off; its summit being nearly straight, and the coronoid process not rising so high as the condyle, the little elevation of this process reminds us of *Macroscelides*. The condyle is not transversely extended, but is rounded. The horizontal ramus and the symphysis are short; the

[1] See De Blainville, *loc. cit.* p. 15, and J. L. Wagner, *loc. cit.* p. 580. See also Hyrtl, *Vergleichend. anat. Untersuch. über das innere Gehörorgan des Menschen und Säugethiere.* Prag. 1845, p. 60.

[2] *Reise nach Mossambique*, p. 71.

angle much produced, expanded and truncated at its extremity, and considerably bent inwards.

There are small double pre-condyloid foramina, and carotid foramen (as in *Talpa*), and a small glenoid one. The foramen ovale is of moderate size and separated by a bony bridge from the large opening representing both the foramen rotundum and sphenoidal fissure, if not the optic foramen also, which I have not detected as a separate opening. The palate is perforated by numerous small apertures, but there are no marked posterior palatine foramina. The anterior palatine foramina are rather small. The infra-orbital foramen is large and single, and bounded above by a moderately stout spiculum of bone. The lachrymal foramen is minute and situated just behind the summit of the anterior end of the just mentioned spiculum. One or two mental foramina open outside the mandible beneath the first or last premolar.

The dentition of this genus, Dr Peters having determined the number of the incisor teeth, appears to be as follows:

$$\text{I.}\,\frac{3-3}{3-3},\ \text{C.}\,\frac{1-1}{1-1},\ \text{P.M.}\,\frac{3-3}{3-3},\ \text{M.}\,\frac{3-3}{3-3}\ \text{or}\ \frac{2-2}{2-2}=\frac{18}{18}\ \text{is}\ \frac{20}{20}=36\ \text{or}\ 40.$$

The 1st upper incisor reminds us of *Scalops*, *Solenodon*, and *Potomogale*; the 2nd is smaller, with a rudimentary anterior cusp, and the 3rd smaller still and quite simple. The upper canine is slightly smaller than the second incisor, and has a small posterior cusp. The 1st premolar has one principal cusp and two small cusps developed from the external cingulum. The 2nd and 3rd premolars, and all the molars, except the occasional 3rd, consist of one long principal cusp, two smaller from the external cingulum, and one internal cusp from the internal cingulum; so that each tooth consists of a single triangular prism with an angle turned inwards; the prism being much extended transversely and very narrow antero-posteriorly, and attached to a supporting surface which develops an internal prominence[1]. The 3rd molar is small and rudimentary, and is absent in some forms.

In the lower jaw the 1st incisor is much smaller than the 2nd, again reminding us of *Scalops*, *Solenodon*, and *Potomogale*. It is exceedingly slender. The 2nd incisor is large and pointed, the 3rd is very small, but has a small posterior cusp. The canine and first premolar are similar, but rather larger in size. The 2nd premolar and the teeth behind it are alike in shape and size; each is a lofty, antero-posteriorly compressed, triangular prism with an angle turned outwards, and separated from its neighbours by an interval. In some species[2] each of those teeth has a small posterior basal talon, but in *C. capensis* this is not the case, and the molars of this species offer the maximum of concentration of the whole order.

[1] See below, woodcut, page 138.

[2] It is so in the specimen of *C. rubra* in the British Museum, and it is so represented in Professor Peters' figure of *C. obtusirostris*. *Reise nach Mossambique*, Tab. XXII. fig. 22a.

I am inclined to think that the species with the reduced number of teeth $\left(\text{i.e. M. } \frac{2-2}{2-2}\right)$ with the basal talon to the lower grinders and destitute of the peculiar prominence in the temporal fossa, should perhaps be separated as a distinct genus from the original form *C. capensis*. It may perhaps be conveniently distinguished under the generic term *Calcochloris*. As regards the rest of the skeleton I can only speak, from observation, of *C. capensis* or *Chyrsochloris* proper. In this form there are 20 or 19[1] dorsal, 3 lumbar, some 3 or 4 sacral, and a few caudal vertebræ. The spinous process of the axis is small, and none are developed on the other cervical vertebræ, the neural arches of which are however more antero-posteriorly developed than in the *Talpidæ*. The transverse processes are not greatly overlapping, nor are there conspicuous cervical hypapophyses. The dorsal spines are fairly developed, except the first two. The lumbar processes are feeble; and there are no hyperapophyses or autogenous hypapophyses, though the first lumbar vetebra developes a hypapophysial ridge. The manubrium though keeled is small; and the clavicle is exceedingly long and slender, and does not articulate with the tolerably long humerus, the internal condyle of which is perforated. The scapula is quite unlike that of the *Talpidæ*, being broad, with a lofty spine, and large, though blunt, metacromion process. The radius and ulna are complete and distinct; and in addition an ossification of a tendon[2] gives a third bone to the fore-arm. The carpus has the scaphoid and semi-lunarê separate[3], no intermedium, and no sickle-shaped ossicle. There are only 4 digits, no one of them has more than 2 phalanges[4].

There is not only no pubic symphysis, but the 2 pubes are wide apart. The ischiatic tuberosities also are somewhat everted. The tibia and fibula are anchylosed together inferiorly. There is a marked difference from *Talpa* in the position of the shoulder-girdle, which is far back, leaving the cervical vertebræ free, instead of more or less concealing them. There are 5 digits to the pes, each with but 2 phalanges[5].

GALEOPITHECUS. The last genus to be here considered is one which has by most naturalists[6] been associated with the Lemurs or Bats, and not with the *Insectivora*, where is, I think, unquestionably its true home.

[1] 19 in the specimen in the Museum of the Royal College of Surgeons, also the number given by De Blainville, *loc. cit.* p. 14, also by Prof. Peters, *loc. cit.* p. 72. In *C. obtusirostris* (my *Calcochloris*) Dr Peters found 19 dorsal, 4 lumbar, and 5 sacral vertebræ, *loc. cit.* p. 72.

[2] Peters, *loc. cit.* p. 72.

[3] *Reise Nach Mossambique*, Pl. XXII. fig. 28, n. s.

[4] Peters, *loc. cit.* p. 72.

[5] Peters, *loc. cit.* p. 73.

[6] See De Blainville, *Ostéographie*, Primates, Lemur, Pl. V. F. Cuvier, *loc. cit.* No. XIV. Owen, *loc. cit.* Pl. CXIV. fig. 1. Waterhouse, *Trans. Zool. Soc.* II. p. 335, Pl. 58. A. Wagner, Dr Peters, and Prof. Huxley have however placed it amongst the Insectivora.

The skull of Galeopithecus is broad and depressed, more resembling, in this respect, *Rhynchocyon* than any other Insectivore, though the muzzle is broader and more obtuse than in that genus. The upper surface of the skull is constricted between the orbits; and the cranium is broadest between the posterior roots of the zygomata, which are complete and stout but exceedingly short arches. The orbits are limited posteriorly by a large post-orbital process, which descends towards but does not nearly attain a very much smaller post-orbital process developed from the upper border of the zygoma. Posteriorly the skull is truncated, but scarcely so in front. A strong ridge bounds the orbit anteriorly, and continues backwards to the post-orbital process just mentioned; moreover there is a very slight process projecting just in front of the lachrymal foramen. Temporal ridges proceed from the upper post-orbital processes, and join, separately, but very near together, the lambdoidal ridge. The temporal fossa is rather small, the muzzle is slightly concave on each side, and a marked concavity is produced on the upper surface of the cranium by the elevation of the superior margin of each orbit. The palate is wide, and without any defects of ossification. Its posterior margin is rather thickened (or rather bent downwards), and extends forwards as far as the anterior end of the penultimate molar, being strongly concave, with a marked backward median projection. The pterygoid fossæ are so minute as to be hardly noticeable. They are somewhat like those existing in *Tupaia*, only still smaller; the divergence of the minute ectopterygoid lamella taking place lower down. The mesopterygoid fossa is large and shallow, narrows slightly backwards as far as the pterygoid fossæ, and then widens a little. It does not end in a posterior excavation, nor does the basi-sphenoid develope lateral processes. The foramen magnum looks directly backwards. There is no paroccipital process, but a large and swollen mastoidal one on each side. The glenoid surface is transversely extended, but made strongly concave antero-posteriorly by the extreme forward curvature of the post-glenoid process, which reminds us of its form in *Sorex*. The cribriform plate is rather small, and the pre- and basisphenoids are not inflated. The premaxillæ are of moderate size, but are widely separated from the frontals, while the nasals become very broad towards their posterior termination. They extend backwards a little further than do the maxillæ above. The parietals form only a moderate part of the cranial roof. The malar is large, and forms part of the floor of the orbit; it is imperforate.

The mandible is remarkable for the very small extent to which the condyle and coronoid process rise above the level of the lower dental series, in which respect *Galeopithecus* resembles *Chrysochloris*, while the coronoid process but mounts little above the condyle, in which respect it approaches *Macroscelides* and its allies. Although the ascending ramus is so little developed, yet the angle is large, rounded, and somewhat arched outwardly, its margin being a little incurved. The symphysis is short, and the horizontal ramus increases in depth from before backwards. Both the outer and inner sides of the ascend-

ing ramus are rather concave. The concavity being superior outwardly, inferior inwardly. The condyle is much extended transversely. The coronoid process is very small, narrow, and rather pointed.

There is a single pre-condyloid foramen on each side, but no carotid or glenoid foramen, nor any kind of ali-sphenoid canal. The optic foramen is large, and the optic nerve does not traverse any long canal. Close to the last-mentioned foramen (and separated from it by a very small lamella) is the opening which represents both the sphenoidal fissure and the foramen rotundum. The foramen ovale is at some distance behind, at the inner side of the glenoid surface. There is no suboptic foramen, but a supra-orbital one at the anterior part of the root of the orbit. There is a small posterior palatine foramen on each side, but a remarkably large anterior palatine. The spheno-palatine foramen is small, and a little below and in front of an orbital-foramen. Two or three very small infra-orbital foramina open on each cheek, and the rather small lachrymal foramen opens just within the margin of the orbit. There is much irregularity in the situation of the mental foramina.

The dentition of this genus may be represented by the formula:

$$\text{I.}\ \frac{2-2}{3-3},\ \text{C.}\ \frac{1-1}{1-1},\ \text{P.M.}\ \frac{2-2}{2-2},\ \text{M.}\ \frac{3-3}{3-3}=\frac{16}{18}=34.$$

The form of the very peculiar incisors and canines in this genus is so well known and has been so often described that it is unnecessary here to describe them again, but it will, I think, be well to call attention to the structure of the last premolar and the three molars, both above and below. Each of these upper teeth consists of 2 triangular prisms with an angle turned inwards, 2 very small cusps internal to the angles just mentioned, and, finally, a very large internal cusp. Of all the forms before reviewed *Urotrichus* is that in which this form of upper molar is most nearly approached[1]. The lower molars each consist of two small triangular prisms (with an angle turned outwards), connected together by a very large cusp or external ridge (convex outwards), a deep depression existing between this external parapet and the two triangular prisms. This shaped lower grinder exists in no other Insectivore, but perhaps the nearest approximation to it may be found in *Sorex*.

As regards the rest of the skeleton, there are 14 dorsal, 5 lumbar, 5 sacral, and many caudal vertebræ[2]. The axis has a moderate spine, and a small one is developed in each cervical vertebra behind it. There are a pair of hypapophysial processes at the posterior end of the under-surface of the bodies of the same vertebræ[3]. All the dorsal and lumbar vertebræ have moderately high spines, which are however much antero-posteriorly extended. The lumbar metapophyses, anapophyses, and transverse processes are small. The ribs are very broad.

[1] See below, woodcut, page 138.

[2] De Blainville says, 13 dorsal, 6 lumbar, and 6 sacral. *Ostéographie*, Primates, Lemur, p. 28.

[3] Mentioned by Prof. Huxley in his Hunterian Lectures for 1865.

The clavicles are long and rather slender; the scapulæ are singularly extended antero-posteriorly, reminding us of those of man, certain apes, and the pteropine bats. There is a well-developed spine, but no metacromian process, though the acromian sends a prolongation forwards; the coracoid is T-shaped[1]. The manubrium is small, and not distinctly keeled. The humerus has its inner condyle perforated, and the ulna is fused inferiorly with the radius. The carpus is provided with a scapho-lunar bone, but there is no os intermedium. The proximal phalanges are much shorter than the median.

The pelvis has a very narrow ilium, without any marked concavity, the pubic symphysis is short but constant. The tuberosities of the ischia are produced slightly backwards. The femur has a third trochanter, the fibula is not only complete inferiorly but it becomes more slender towards its upper end than towards its lower termination, thus shewing a tendency to approach the cheiropterous type of structure. The metatarsus is shorter than the digits of the pes, but longer than the tarsus. Each extremity is furnished with fine unguiculate digits.

With *Galeopithecus* ends the list of insectivorous genera; and now it may be well to review the more remarkable characters which we have seen presented by the various forms. First, with regard to the general form of the skull: the two extremes are presented by *Centetes*, *Ericulus*, and *Echinops*, on the one hand; and *Macroscelides*, *Petrodromus*, *Tupaia*, and *Chrysochloris*, on the other. In *Rhynchocyon* and *Galeopithecus* it is, we have seen, exceptionally broad in proportion to its height.

The cranium is almost always broadest between the posterior roots of the zygoma or glenoid surfaces; but in *Talpa*, *Condylura*, *Scalpus*, *Scapanus*, *Urotrichus*, and *Myogale*, the greatest breadth is more posteriorly situated. In the same genera, and in *Sorex*, the supra-occipital is exceedingly developed, extending far forwards. In the last-mentioned genus, as also in *Centetes*, *Ericulus*, *Echinops*, *Solenodon*, and *Potomogale*, there is no zygomatic arch. In the other genera it is present, though generally more or less slender, and exceedingly so in *Talpa* and its allies. On the other hand, in *Chrysochloris* it is deep; and it is very well-developed, though short, in *Galeopithecus*. Post-orbital processes are entirely absent, except in *Rhynchocyon*, *Hylomys*, *Galeopithecus*, *Ptilocercus*, and *Tupaia*. In the last-named genus alone is the orbit completely encircled by bone, though it is almost so in *Ptilocercus*. In these two genera and in *Hylomys* there is a malar perforation. In *Tupaia*, *Erinaceus*, and *Gymnura*, there is a ridge in front of the orbit, and in *Galeopithecus* the orbital margin is very sharp. A more or less marked process also projects outwards in front of the lachrymal foramen in these genera (with the exception of *Tupaia*) and also in *Solenodon*. A very large lambdoidal ridge exists in *Centetes*, *Solenodon*, *Gymnura*, and sometimes in

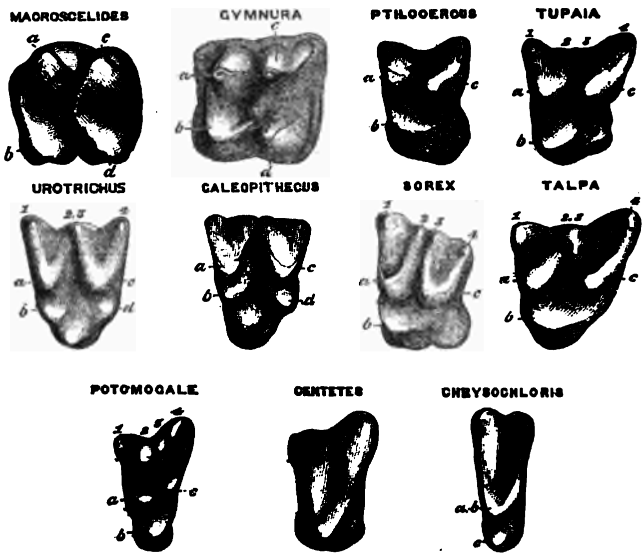
[1] These points, as well as the shortness of the proximal phalanges, were noticed by Prof. Huxley in his Hunterian Lectures for 1865.

Sorex. In *Sorex* and *Galeopithecus* the post-glenoid process projects very strongly forwards as it descends. The premaxilla is produced strongly forwards in *Solenodon*, *Chrysochloris*, and *Calcochloris*, but in no others. Defects of ossification in the palate occur in widely-different forms, namely, in *Erinaceus*, *Talpa*, *Myogale*, *Tupaia*, *Macroscelides*, *Petrodromus*, and *Solenodon.* The posterior margin of the palate is more or less thickened in *Centetes*, *Solenodon*, *Erinaceus*, *Gymnura*, *Myogale*, *Ptilocercus*, and *Galeopithecus.* In *Erinaceus* and *Gymnura* only is there a transverse bony plate behind this thickening. No pterygoid fossa exists in *Talpa*, *Condylura* (?), *Scalops*, *Centetes*, *Ericulus*, *Echinops*, *Solenodon*, *Potomogale*, *Chrysochloris*, and *Calcochloris.* The mesopterygoid fossa often narrows as it extends backwards, but only in *Centetes*, *Ericulus*, and *Erinaceus*, does it end in an excavation of the *basis cranii.* An ali-sphenoid canal exists in *Centetes*, *Ericulus*, *Solenodon*, and *Potomogale*, and probably also in *Echinops*, but in no other form. An external ali-sphenoidal canal is to be found in *Gymnura*, *Tupaia*, *Ptilocercus*, and probably also in *Hylomys.* Paroccipital processes exist in *Centetes*, *Ericulus*, *Echinops*, *Solenodon*, *Erinaceus*, and *Gymnura*, also in *Potomogale*, where they are peculiarly bent backwards. Well-developed mastoid processes are to be found in *Galeopithecus*, *Erinaceus*, *Gymnura*, *Ericulus*, and *Echinops.* The two nasal bones anchylose together rapidly in the two last-mentioned genera, and also in *Centetes*, *Solenodon*, and *Potomogale.*

A distinct carotid foramen does not appear to exist in those genera in which the nasal bones soon unite together, nor in *Erinaceus*, *Gymnura*, and *Sorex;* but in the other genera there is a foramen, which probably serves for the carotid artery. A large pterotic bone is only found in *Talpa* and its allies. The foramen rotundum is distinct from the sphenoidal fissure in *Tupaia*, *Gymnura*, and generally in *Erinaceus;* and in the two last genera, and in them only, the optic nerve traverses a more or less long, though very small, bony canal. In the same two genera, as also in *Macroscelides*, *Petrodromus*, *Rhynchocyon*, and *Potomogale*, there is a sub-optic foramen. I have not observed this in other genera. The infra-orbital canal is single, except in *Galeopithecus;* it is generally a short canal, but it is more or less prolonged in *Erinaceus*, *Gymnura*, *Tupaia*, *Hylomys*, and *Sorex.* In *Macroscelides*, *Petrodromus*, *Rhynchocyon*, and *Galeopithecus* the lachrymal foramen opens well within the orbit. In the others it is at, or in front of, the anterior margin of the orbit; and in *Talpa* it is well forwards on the cheek. The exceedingly truncated ascending ramus of *Chrysochloris* is peculiar to that family; and the deep fossa inside the mandible of *Sorex* is found exclusively in the *Soricidæ.*

There are very generally 3 incisors above, and 3 below, on each side, but there are several genera in which this is not the case. The 1st upper incisor is mostly much larger than the 2nd; but in the lower jaw the 2nd is often (as is *Centetes*, *Ericulus*, *Echinops*, *Solenodon*, *Potomogale*, *Scalops*, *Myogale*, and *Chrysochloris*) much larger than the 1st. An incisor has sometimes two fangs, as in

Galeopithecus and *Petrodromus;* and very often the upper canine is similarly furnished. In *Echinops*, *Sorex*, and *Galeopithecus* there are less than 3 premolars above; and in the same genera and in *Erinaceus* there are less than 2 such below. In *Gymnura*, *Talpa*, *Condylura*, *Scapanus*, *Myogale*, and *Hylomys*, there are more than 3 premolars both above and below. The true molar teeth of the upper jaw in the Insectivora exhibit an interesting series of modifications, from *Macroscelides*, on the one hand, to *Chrysochloris* on the other; and these modifications parallel in a remarkable manner, and the difference presented by the different genera of Marsupials[1].



Grinding surfaces of left upper molars of different genera.
a. antero-external cusp. *b.* antero-internal cusp. *c.* postero-external cusp. *d.* postero-internal cusp. 1, 2, 3, 4, cusps of external cingulum.

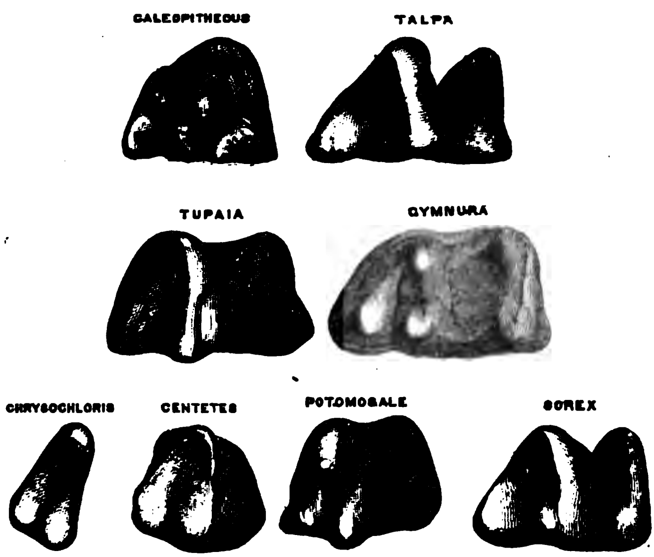
An upper molar, as we have seen, may sometimes, as in *Erinaceus* and *Gymnura*, present 4 well-developed cusps (the antero-internal and postero-external ones being united by an oblique ridge) and a small external cingulum. These 4 cusps may, as in *Macroscelides*, *Petrodromus*, and *Rhynchocyon*, be united by transverse ridges—one such ridge joining the anterior pair of cusps, the other the posterior pair. This very peculiar form of tooth is more or less approached by that seen in *Phalangista* and the *Macropodidæ;* and it is the more singular that there should be this resemblance between the

[1] See Waterhouse's *Natural History of the Marsupiata.* Pl. XXII. figs. 4 to 11, and p. 552.

molars of these long-legged, long-footed, saltatory, African Insectivores and those of the kangaroos and kangaroo rats, as the upper incisors also shew a certain degree of resemblance[1].

Sometimes the external cingulum is more developed as in *Ptilocercus;* and in *Tupaia* it is still more so, producing, in conjunction with the two outer principal cusps, the appearance of two triangular prisms; while the postero-internal principal cusp becomes much diminished in size. In other forms the external cingulum developes 3 or 4 small but distinct cusps; which, being united by ridges with the external pair of principal cusps, form with them two very well-marked triangular prisms, as in *Talpa,* where the postero-internal principal cusp has disappeared.

Sometimes, however, all four principal cusps coexist with those of the external cingulum, together with an additional prominence of the internal cingulum. This may be seen in *Urotrichus,* but especially in *Galeopithecus,* when the molar exhibits the maximum of complexity in the order. *Potomogale* shows, as has been said, a very interesting approximation of the triangular prisms; the two external principal cusps still however remaining distinct, though in close juxtaposition. In *Centetes* it appears as if the concentration had been carried further, the two prisms uniting into one, as also the



Grinding surfaces of right lower molars of different genera.

[1] The resemblance between the structure of the molar teeth of the *insectivorous* Marsupials and that of the molars of many placental Insectivora has often been remarked.

two external principal cusps. The single representative of these, however, has two small prominences on its inner side. In *Chrysochloris* we have the maximum of concentration, there being but a single triangular prism, the internal angle of which represents the two external principal cusps of *Erinaceus* and others, while internal to this there is but a single prominence to represent the two internal principal cusps.

The lower molars present less variation in shape, consisting generally of two triangular prisms, which may be, as in *Talpa*, about equally developed; or the posterior may be more or less abortive. This abortion is very marked in *Potomogale*, more in *Centetes* and *Solenodon*, and most in *Chrysochloris Capensis*, where each molar is reduced to an absolutely single triangular prism, separated from its neighbour by a marked interval. One very large lower incisor on each side is a condition peculiar to Sorex.

As regards the rest of the skeleton the most prominent features are as follows. The number of dorsal and lumbar vertebræ taken together is pretty uniform, ranging and varying from 19 (or very rarely 18) to 23 or very rarely 24. The dorsal vertebræ are most numerous in *Chrysochloris* (19 or 20), and then in *Centetes* (18 or 19). In other forms there are often but 13 such. The lumbar vertebræ are 8 in *Rhynchocyon*, in *Chrysochloris* but 3. The sacral vertebræ vary from 3 to about 5 in number. The spine of the axis is largely developed in *Centetes*, *Solenodon*, *Potomogale*, *Gymnura*, *Macroscelides*, *Petrodromus*, and *Rhynchocyon*. In *Talpa*, as Professor Owen has shown[1], the transverse processes of the cervical vertebræ are singularly expanded antero-posteriorly. The caudal vertebræ are few in number in *Erinaceus*, *Centetes*, *Ericulus*, *Echinops*, *Talpa*, *Condylura*, *Scalops*, *Scapanus*, *Urotrichus*, *Chrysochloris*, *Calcochloris*, and *Hylomys;* in the other genera they are numerous. In *Talpa* and its allies as also in the *Chrysochloridæ* the 5 posterior cervical vertebræ are destitute of spines; but in the last-named family the dorsal spines are rather long, and they are very so in *Macroscelides*, *Petrodromus*, *Rhynchocyon*, *Solenodon*, *Potomogale*, and *Centetes*. The lumbar spines are much antero-posteriorly extended in the last three genera in *Echinops*, in *Galeopithecus*, and doubtless also in *Ericulus*. The lumbar transverse processes are very long in *Tupaia*. In *Macroscelides*, *Petrodromus*, and *Rhynchocyon*, they are much developed antero-posteriorly, and in all four genera the metapophyses are large. Large cervical hypapophyses exist only in *Sorex* and *Potomogale*[2]. In *Talpa* and its allies there are hypapophysial ossicles beneath the interspaces of the lumbar vertebræ; and processes are developed, in *Tupaia*, beneath some of the trunk vertebræ. Hyperapophyses are well marked in *Centetes*, *Echinops* (no doubt *Ericulus* also), *Solenodon*, *Potomogale*, *Sorex*, *Macroscelides*, *Petrodromus*, and *Rhynchocyon*.

The peculiar developement of the manubrium, clavicle, and hu-

[1] *Anatomy of Vertebrates*. II. p. 386. [2] Allman, *loc. cit.* p. 8.

merus of *Talpa* and its allies is familiar to all. The clavicle is present in all except *Potomogale*. It is exceptionally slender, however, in *Chrysochloris*. There is almost always a supracondyloid foramen in the humerus; though in *Erinaceus* it is generally absent, and sometimes so in *Sorex*. It is also wanting in *Potomogale*[1]. The radius and ulna are both completely developed, except in *Galeopithecus*, *Macroscelides*, and *Petrodromus*. There is a scapho-lunar bone in *Galeopithecus*, *Tupaia*, *Centetes*, *Solenodon*, *Erinaceus*, *Gymnura*, and *Talpa*, and its allies. An os intermedium exists in the same genera, except *Galeopithecus*, and also in *Ericulus*, *Macroscelides*, *Petrodromus*, and *Rhynchocyon*.

The pubic symphysis is generally very small or absent; but it is long in the three last-mentioned genera and in *Tupaia*, and most probably also in *Ptilocercus* and *Hylomys*. The tibia and fibula are generally anchylosed together inferiorly, but they are complete and separate in *Galeopithecus*, *Tupaia*, *Centetes*, *Ericulus* (most likely also in *Echinops*), and *Solenodon*. The metatarsus is exceptionally elongated in *Rhynchocyon*, *Petrodromus*, and *Macroscelides;* and in the last two genera and in the *Chrysochloridæ* alone amongst Insectivores are there less than five digits to each extremity.

As Professor Peters has pointed out[2] *Tupaia*, *Macroscelides*, *Rhynchocyon*, and *Galeopithecus*, differ from the rest of the order in the possession of a cœcum.

The affinities which become evident from the variations in structure above enumerated correspond, as I observed in the first part of my paper, very closely to those already detected by Professor Peters, who divides the Insectivores into seven families, as follows:

1. Galeopitheci :—*Galeopithecus.*
2. Tupayæ :—*Cladobates*, *Ptilocercus*, *Hylomys.*
3. Macroscelidoidæ :—*Rhynchocyon*, *Macroscelis.*
4. Centetina :—*Solenodon*, *Centetes*, *Ericulus*, *Echinogale*, *Potomogale*[3].
5. Erinaceina :—*Erinaceus*, *Gymnura.*
6. Talpina :—*Myogale*, *Urotrichus*, *Condylura*, *Scalops*, *Talpa*, *Chrysochloris.*
7. Sorices :—*Sorex.*

Nevertheless there are many cross-relationships between these families; and, of course, it is quite impossible to arrange them naturally in any single series. Yet I do not think that they can be united in any larger natural groups, but on the contrary, that even two more primary divisions may well be instituted, and the order *Insectivora* be made to consist of nine natural families; *Potomogale* being on

[1] Allman, *loc. cit.* p. 12.

[2] Table of a classification proposed for the Insectivora at the end of the article on *Solenodon Cutanus* before referred to. *Abhand. d. K. Akad. d. W. zu Berlin*, 1864. p. 20.

[3] I add *Potomogale* here because Dr Peters has recently published his opinion that it should form part of the *Centetina*. See *Monatsbr. Akad. W. Berlin*, 1865, p. 296.

the one hand separated from Dr Peters's *Centetina*, and *Chrysochloris* from his *Talpina*. It is true that *Potomogale* agrees with the *Centetina* in the presence of the ali-sphenoid canal, the anchylosed nasals, the absence of a zygoma, and the presence of hyperapophyses, and some other points, but the peculiarities before enumerated, some of which are repeated below, appear to me to fully justify its separation.

Chrysochloris and *Calcochloris* resemble Dr Peters's Talpina in certain characters; but these appear to me to be *adaptive*, not essential; while the remarkable form of the molars (an exaggeration of the *Centetes* type), together with the slender clavicle and numerous dorsal vertebræ, would almost induce me to regard it as rather a modification of a type allied to *Centetes* and *Potomogale* than of one allied to *Talpa*, and its geographical distribution strongly confirms this view.

The genera *Erinaceus* and *Gymnura* have many relations with Dr Peters's *Tupayæ*, as the presence of a scapho-lunar bone and an os intermedium, the pterygoid fossa, the distinct foramen rotundum, also, a considerable similarity in the form of the molars, and some other points, as well as geographical distribution. On the other hand, the same two genera resemble *Talpa* and its allies in the union of the tibia and fibula, the absence of any post-orbital process and of a cœcum. Although the presence of a cœcum tends to connect Dr Peters's *Macroscelidoidæ* with his *Tupayæ*, as also do the presence of an os intermedium, the long pubic symphysis, the large metapophyses, and the carotid and glenoid foramina, yet they are widely separated by other characters, and indeed the structure of the molars in the former groups isolates it from all the other families of the order. In the presence of the peculiar sub-optic foramen it allies itself with *Erinaceus*, *Gymnura*, and *Potomogale*.

On the whole, the arrangement of the Insectivora given at the commencement of the first part of this memoir, is the one which appears to me to be the most natural. The number of families may appear great in comparison with that of the genera. But such a condition might be expected in an order consisting of forms which are the survivors of many kindred extinct organisms; and M. Pornel has called attention, in his very interesting memoir[1], to the numerous and varied insectivorous forms which have become extinct in Europe since the Miocene period.

The characters of the several groups, as derived from the skeleton, the dentition, the presence or absence of a cœcum, and from geographical distribution, may be thus expressed:

GALEOPITHECIDÆ. GALEOPITHECUS. Pallas[2].

Dentition. $\text{I.}\ \frac{2-2}{3-3},\ \text{C.}\ \frac{1-1}{1-1},\ \text{P.M.}\ \frac{2-2}{2-2},\ \text{M.}\ \frac{3-3}{3-3} = 34.$

[1] *Bulletin de la Soc. Géologique de France*. 1849. Vol. VI. p. 56.

[2] Pallas. *Acct. Petrop.* IV. I. p. 208, Tab. VIII. De Blainville, *Ostéographie*, Lemur. Pls. VI. VIII. IX. Waterhouse, *Trans. Zool. Soc.* II. p. 335, Pl. LVIII. Wagner, *Schreb. Supplem.* I. p. 318, V. p. 522.

Cranium broad, depressed; muzzle obtuse; skull broadest between posterior roots of zygomata, which are complete and strong, but short; well-developed post-orbital processes, sometimes enclosing orbits; margin of orbit sharp, with a small process in front; orbit large, temporal fossa rather small; no ali-sphenoid canal; concave posterior margin of palate far forwards; pterygoid fossa minute; no basi-sphenoidal or paroccipital processes; large swollen mastoid process on each side; strong post-glenoid process, tending much forwards; optic foramen large; foramen rotundum and sphenoidal fissure represented by one opening; a supra-orbital, but no sub-optic foramen; several small sub-orbital foramina on each side; anterior palatine foramina very large; lachrymal foramen small, opening within the orbit; upper canine and second incisor each with two roots; lower incisors pectinated; upper and lower molars very complex; 13 or 14 dorsal, 5 or 6 lunar, 5 or 6 sacral, and many caudal vertebræ; ribs very broad; clavicles long, a scapho-lunar bone, but no os intermedium; ulna anchylosed to radius; fibula complete, but smallest towards its upper end; metatarsals shorter than digits; 5 digits to each extremity; a large cœcum. *Habitat.* South-eastern Asia and Indian Archipelago.

MACROSCELIDIDÆ.

Dentition. I. $\frac{}{3-3}$, C. $\frac{1-1}{1-1}$, P.M. $\frac{3-3}{3-3}$.

Skull broadest between posterior roots of zygomata, which are complete and rather deep; orbits not encircled by bone; generally no post-orbital processes; dorsum of muzzle concave transversely; palate sometimes decidedly extending backwards beyond last molar; orbit large, temporal fossa very small; no ali-sphenoid canal, malar imperforate; carotid, post-glenoid, and sub-optic foramina; one opening representing both sphenoidal fissure and foramen rotundum; foramen ovale large; lachrymal foramen opening well within the orbit; coronoid process of mandible not rising much, if at all, above condyle; canine close to premaxillary suture; last upper premolars not more vertically extended than the true molars; upper molars quadricuspid, the anterior and posterior cusps being connected by transverse ridges; 13 dorsal and 6 or 8 lumbar vertebræ; lumbar transverse processes much extended antero-posteriorly; no hyperapophyses; hypapophyses beneath lumbar vertebræ; scapula with a long metacromion; clavicles slender; scaphoid and semi-lunar separate; pelvic symphysis elongated; metatarsus as long as, or longer than, digits, and much longer than tarsus; sometimes only 4 digits; a cœcum. *Habitat.* Africa.

MACROSCELIDES[1]. Smith.

Dentition. I. $\frac{3-3}{3-3}$, M. $\frac{3-3}{3-3}$ or $\frac{3-3}{4-4}$.

[1] De Blainville, *Ostéographie.* Insectivores, p. 57, Pls. III. V. VII. VIII. X. Wagner, *Schreber Supplem.* II. p. 81, V. p. 534. Duvernoy, *Mém. de Strasb.* I.

Skull sometimes much inflated by air cavities; always much contracted between orbits; no post-orbital process; large defects of ossification in the palate; pterygoid fossa extending forwards to posterior margin of palate; sub-optic foramen not conspicuous; infra-orbital canal very short, the lachrymal foramen opening immediately above posterior termination of infra-orbital canal; angle of mandible elongated; upper incisors and canines all of much the same size; third incisor with a single root; third lower molar but little smaller than the first or second; 6 or 7 lumbar vertebræ; cervical spines very rudimentary; ulna anchylosed to radius; five digits to each extremity. *Habitat.* Africa, including the northern part.

PETRODROMUS[1]. Peters.

Dentition. $\text{I.}\,\frac{3-3}{3-3},\ \ \text{M.}\,\frac{3-3}{3-3}.$

A strongly-marked sagittal ridge; skull never much inflated; no post-orbital process; large defects of ossification in the palate; pterygoid fossa extending forwards to the posterior margin of palate; sub-optic foramen conspicuous; infra-orbital canal short; angle of mandible elongated; first upper incisor very much larger than the second; third incisor with two roots; third lower molar but little smaller than the first or second; 7 lumbar vertebræ; cervical spinous processes very small; ulna anchylosed to radius; 5 digits to the manus, 4 to the pes. *Habitat.* Eastern Africa.

RHYNCHOCYON[2]. Peters.

Dentition. $\text{I.}\,\frac{1-1}{3-3}\ \text{or}\ \frac{0-0}{3-3},\ \ \text{M.}\,\frac{3-3}{3-3}.$

A strongly-marked sagittal ridge; skull never much inflated; cranium proper, broad, flattened above and very little narrowed between the orbits; a marked post-orbital process; no defects of ossification in the palate; pterygoid fossa not nearly extending so far forwards as the posterior margin of the palate; premaxilla very small; sub-optic foramen conspicuous; infra-orbital canal very long, the lachrymal foramen opening in front of its posterior termination; angle of mandible very short; canine very much larger than the incisor, and with two roots; third lower molar considerably smaller than the first or second one; 8 lumbar vertebræ; cervical spines pretty well developed; ulna complete; only 4 digits to either manus or pes. *Habitat.* Eastern Africa.

Tab. I. II. III. p. 50. Dr Andrew Smith, *Zool. South Africa*, Pl. XV. Prof. Peters, *Reise Nach. Mossambique*, p. 87, Tab. XXII. Geoff. St Hilaire, *Ann. Sc. Nat.* 1829. XVIII. p. 165—173.

[1] Prof. Peters, *Reise nach Mossambique*, p. 92, Tab. XXII. and XXIII. Wagner, *Schreb. Supplem.* v. p. 538.

[2] Prof. Peters, *Reise nach Mossambique*, p. 100, Tab. XXII. and XXIII. Wagner, *Schreb. Supplem.* v. p. 581.

TUPAIIDÆ.

$$\text{I.} \frac{}{3-3}, \quad \text{C.} \frac{1-1}{1-1}, \quad \text{M.} \frac{3-3}{3-3};$$

skull broadest between the posterior roots of the zygomata, which are complete and slender; orbits enclosed by bone or at least a post-orbital process; dorsum of muzzle convex transversely; an external ali-sphenoid canal; molar perforated; carotid and post-glenoid foramina, but no sub-optic foramen; foramen ovale a narrow aperture widely separated from the spheno-orbital opening; lachrymal foramen at margin of orbit or rather without it; coronoid process of mandible rising much above condyle; canine not close to premaxillary suture; upper molars with four more or less marked principal cusps and an external cingulum, which tends to form, with the two outer principal cusps, two triangular prisms; 13 dorsal, 5 to 7 lumbar vertebræ; lumbar transverse processes not much antero-posteriorly extended; well-developed hyperapophyses; no hypapophyses; scapula with only a rudimentary metacromion; clavicles slender; a scapho-lunar bone and os intermedium; pelvic symphysis elongated; tibia and fibula distinct[1]; metatarsus but very little longer than the tarsus; 5 digits to each extremity; a cœcum. *Habitat.* South-eastern Asia and the Indian Archipelago.

TUPAIA[2]. Raffles.

Dentition. $\text{I.} \frac{2-2}{3-3}, \quad \text{C.} \frac{1-1}{1-1}, \quad \text{P.M.} \frac{3-3}{3-3}, \quad \text{M.} \frac{3-3}{3-3};$ skull much narrowed anteriorly; zygoma very slender; orbits large and completely encircled by bone; anterior margin of orbit sharply prominent; a process above the lachrymal foramen; temporal fossa very small; posterior margin of palate not thickened; small defects of ossification in palate; pterygoid fossa very small, and distant from palate; no paroccipital process; post-glenoid process rudimentary; molar with a large perforation; foramen rotundum distinct from spheno-orbital fissure; a supra-orbital foramen; infra-orbital canal long and narrow; posterior palatine foramen large; cingulum of upper molars developing cusps; triangular prisms rather well-developed; the two hinder upper premolars much more vertically extended than the true molars; caudal vertebræ numerous. *Habitat.* South-eastern Asia and Indian Archipelago.

PTILOCERCUS[3]. Gray.

Dentition. $\text{I.} \frac{2-2}{3-3}, \quad \text{C.} \frac{1-1}{1-1}, \quad \text{P.M.} \frac{3-3}{3-3}, \quad \text{M.} \frac{3-3}{3-3};$ skull much

[1] I presume that *Ptilocercus* and *Hylomys* agree with Tupaia in this character.

[2] Horsfield's *Zool. Researches*, 1824. 8 plates. Raffles, *Linn. Trans.* XIII. p. 257. Müller und Schlegel. *Verhandel.* 1839—1844. De Blainville, *Insectivores.* Pls. III. VI. and X. F. Cuvier's *Dents des Mammifères*, No. XVII. Owen's *Odontography*, Pl. CXI. fig. 3. Wagner, *Schreb. Supplem.* II. p. 37, V. p. 525.

[3] Gray, *Pro. Zool. Soc.* 1848, p. 24, and *Zoology of Voyage of H.M.S. Samarang*, 1850, p. 18, Pl. 5. Wagner, *Schreber Supplem.* V. p. 528.

narrowed behind the post-orbital processes; orbits very nearly encircled by bone; the anterior margin of each not sharply prominent; no process above the lachrymal foramen; temporal fossa large; posterior margin of palate slightly thickened; no defects of ossification in palate; pterygoid fossæ distant from palate; a ridge-like paramastoid process; post-glenoid process rather large; malar perforation very small; foramen rotundum and spheno-orbital fissure represented by a single opening; no supra-orbital foramen; infra-orbital canal large, but very short; posterior palatine foramen very small; external cingulum of upper molars not developing distinct cusps; last upper premolar much more vertically extended than the true molars, caudal vertebræ numerous. *Habitat.* Borneo.

HYLOMYS[1]. Müller and Schlegel.

Dentition. I. $\frac{3-3}{3-3}$, C. $\frac{1-1}{1-1}$, P.M. $\frac{4-4}{4-4}$, M. $\frac{3-3}{3-3}$; skull not much narrowed anteriorly; rather so between the orbits; only a small post-orbital process; a process above the lachrymal foramen; no defects of ossification in palate; pterygoid fossæ extending forwards to posterior margin of palate; malar with a small perforation; infra-orbital canal rather large, but not much elongated; no supra-orbital foramen; external cingulum of upper molars not developing cusps; last upper premolar much more vertically extended than the true molars; caudal vertebræ few in number. *Habitat.* Java, Sumatra, and South-eastern Asia.

ERINACEIDÆ.

I. $\frac{3-3}{}$ C. $\frac{1-1}{1-1}$, M. $\frac{3-3}{3-3}$; skull broadest between the posterior roots of the zygomata, which are complete, though somewhat slender; no post-orbital process; a ridge and process in front of orbit; temporal fossa large; pterygoid fossæ well developed; a transverse ridge at posterior part of palate, with a narrow transverse plate behind it; paroccipital and mastoid processes; nasals separate; malar imperforate, small, suspended in zygoma; a glenoid but no distinct carotid foramen; foramen rotundum distinct from sphenoidal fissure; optic nerve traversing an elongated and very small canal; a sub-optic foramen; infra-orbital canal rather long; no true ali-sphenoid canal; lachrymal foramen opens just in front of orbit; ascending ramus of mandible very concave externally; first two upper molars quadricuspid, with an oblique ridge in each connecting the postero-external cusp with the antero-internal one; 14 or 15 dorsal vertebræ and 5 or 6 lumbar vertebræ; no hyperapophyses or hypapophyses; all lumbar processes small; clavicles slender; scapula with a long, pointed metacromion process; ulna complete and distinct; a scapho-lunar bone and os

[1] Müller und Schlegel, *Verhandel.* I. p. 50, Tab. XXV. fig. 4—7. Wagner, *Schreber Supplem.* II. p. 554, and V. p. 530. Blyth, *Journal Asiatic Soc.* Bengal, 1859, p. 293.

intermedium; pubic symphysis very small or absent; fibula anchylosed below to tibia; metatarsus short; 5 digits to each extremity; no cæcum. *Habitat.* Europe, Asia, Africa.

ERINACEUS[1]. Linnæus.

I. $\frac{3-3}{2-2}$, P.M. $\frac{3-3}{2-2}$; skull slightly constricted between the orbits; transverse plate behind the posterior palatine ridge, continuous with outer walls of pterygoid fossæ; defects of ossification in palate; no external ali-sphenoid canal; mesopterygoid fossa ending posteriorly in an excavation of the *basis cranii*; sub-optic foramen small and hidden; spheno-palatine foramen close to the foramen rotundum; upper canine small, generally with two roots; third upper and lower molars very small; 3 sacral vertebræ; caudal vertebræ not numerous; spinous process of axis moderate; humerus generally with no supracondyloid foramen; tuberosity of ischium not much prolonged backwards; femur with a moderate ecto-gluteal ridge. *Habitat.* Europe, Asia, Africa.

GYMNURA[2]. Vigors and Horsfield.

I. $\frac{3-3}{3-3}$, P.M. $\frac{4-4}{4-4}$; skull much constricted between the orbits; transverse plate behind posterior ridge of palate, not continuous with outer walls of pterygoid fossæ; no defects of ossification in palate; an external ali-sphenoid canal; meso-pterygoid fossa not ending posteriorly in any excavation; sub-optic foramen large and conspicuous; spheno-palatine foramen remote from foramen rotundum; upper canine large and conical, with one root; third upper molar quadricuspidate; third lower molar quite like the second; 5 sacral vertebræ; caudal vertebræ numerous; spinous process of axis very large; tuberosity of ischium much prolonged backwards; femur with a very strong ecto-gluteal ridge. *Habitat.* Malacca, Sumatra.

CENTETIDÆ.

I. $\frac{2-2}{}$, C. $\frac{1-1}{1-1}$, M. $\frac{3-3}{3-3}$;

skull very cylindrical, broadest between the glenoid surfaces; no zygoma; no post-orbital process; no process and, generally, no ridge in front of the orbit; temporal fossa large; no pterygoid fossa; paroccipital and mastoid processes; nasals united; malar imperforate; a glenoid, but no distinct carotid foramen; foramen rotundum one with sphenoidal fissure; optic foramen very small, but not forming a long

[1] De Blainville, *Insectivores*, p. 86, Pl. VI. VII. VIII. and X. F. Cuvier, *Dents des Mammifères*, No. XVI. Owen, *Odontography*. II. Pl. CX. fig. 5. Wagner, *Supple.* II. p. 10.

[2] De Blainville, *Insectivores*, Pl. VI. and X. Owen, *Odontography*. II. Pl. CXI. fig. 4. Horsfield and Vigors, *Zoolog. Journal.* III. p. 246, Pl. VIII. Wagner, *Schreb. Supplem.* II. p. 45, V. p. 538.

canal; no sub-optic foramen; infra-orbital canal short and wide; lachrymal foramen opening close to, or just in front of, anterior margin of orbit; a true ali-sphenoid canal; no external ali-sphenoid canal; upper true molars each forming one triangular prism, the two external principal cusps of a quadricuspid molar being here represented by a single prominence; lower true molars with very small posterior processes; 15 to 19 dorsal vertebræ; lumbar processes small; no hypapophyses in the trunk, but distinct hyperapophyses; scapula with an obtuse metacromion process; a supra-condyloid foramen to humerus; an os intermedium; pubic symphysis very small; tibia and fibula distinct[1]; metatarsus short; 5 digits to each extremity; no cœcum. *Habitat.* Madagascar and West Indies.

CENTETES[2]. Illiger.

I. $\frac{2-2}{3-3}$, P.M. $\frac{3-3}{3-3}$; no inter-orbital constriction; skull exceedingly cylindrical; posterior margin of palate thickened; meso-pterygoid fossa ending posteriorly in an excavation of the *basis cranii*; a slightly-marked prominence from the inferior margin of the mandible, and placed some distance in front of the angle; a glenoid foramen; posterior palatine foramen large; no defects of ossification in palate; ascending ramus of mandible only slightly concave externally; canines long, pointed; apex of lower canine received into a fossa; first upper incisor small; second upper premolar not like the true molars; 18 or 19 dorsal vertebræ; a scapho-lunar bone. *Habitat.* Madagascar.

ERICULUS[3]. Is. Geoff.

I. $\frac{2-2}{2-2}$, P.M. $\frac{3-3}{3-3}$; no inter-orbital constriction; posterior margin of palate not thickened, and projecting much backwards beyond the last molars; meso-pterygoid fossa ending posteriorly in an excavation of the *basis cranii*; no glenoid foramen; no defects of ossification in palate; posterior palatine foramen small; ascending ramus of mandible only slightly concave externally; canines not much elongated; second upper premolar shaped like the true molars; scaphoid and semi-lunar bones separate. *Habitat.* Madagascar.

ECHINOPS[4]. Martin.

I. $\frac{2-2}{2-2}$, P.M. $\frac{2-2}{2-2}$; no inter-orbital constriction; posterior margin

[1] I presume that *Echinops* agrees with the other genera of the *Centetidæ* in this character.

[2] De Blainville, *Insectivores*. Pl. IV. VI. and X. F. Cuvier, *Dents des Mammifères*, No. XIX. Owen, *Odontography*. Pl. CX. fig. 6. Wagner, *Schreb. Supplem.* II. p. 30, V. p. 582.

[3] Is. Geoff. *Mag. de Zool.* 1839, p. 25. De Blainville, *Insectivores*. Pl. VI. and X. Wagner, *Schreb. Supplem.* II. p. 33 and 551, and V. p. 584. Peters, *Monatsber. Akad. Wissen. Berlin.* 1865, p. 286.

[4] Martin, *Trans. Zool. Soc.* II. p. 249, Pl. XLVI. Peters (Echinogale),

of palate not thickened, and projecting a little beyond last molars; meso-pterygoid fossa not ending posteriorly in an excavation of the *basis cranii*; posterior palatine foramen small; ascending ramus of mandible only slightly concave externally; first upper incisor much larger than the second; canines not much elongated; second upper premolar shaped like the true molars. *Habitat.* Madagascar.

SOLENODON[1]. Brandt.

I. $\frac{2-2}{2-2}$, P.M. $\frac{4-4}{4-4}$; skull not very cylindrical; cranium somewhat constricted between the orbits; posterior margin of palate thickened; a ridge in front of the orbit; meso-pterygoid fossa not ending posteriorly in an excavation of the *basis cranii*; no paroccipital process; premaxilla somewhat produced; ascending ramus of mandible deeply concave externally; condyle much transversely extended; a sharp process from the inferior margin of the mandible some distance in front of the angle; large glenoid foramen; posterior palatine foramen moderate; lachrymal foramen just in front of the orbit; first upper incisor much larger than the second; canine very small; apex of second lower incisor received into a fossa; 15 dorsal vertebræ; a scapho-lunar bone. *Habitat.* Hayti and Cuba.

POTOMOGALIDÆ[2]. POTOMOGALE. Du Chaillu.

Dentition. I. $\frac{3-3}{3-3}$, C. $\frac{1-1}{1-1}$, P.M. $\frac{3-3}{3-3}$, M. $\frac{3-3}{3-3}$; skull not cylindrical; broadest between the glenoid surfaces; no zygoma; no post-orbital process; no ridge or process in front of the orbit; temporal fossa large; no pterygoid fossa; paroccipital processes directed backwards; nasals united; molar imperforate; very large precondyloid perforations; a small glenoid but no distinct carotid foramen; foramen rotundum one with spheno-orbital fissure; optic-foramen very small, but not forming a long canal; a sub-optic foramen; infra-orbital canal short and wide; no lachrymal foramen; a true ali-sphenoid canal; no external ali-sphenoid canal; upper true molars each forming two very narrow and approximated triangular prisms, the two external principal cusps of a quadricuspid molar being represented by two distinct prominences; lower true molars with rather large posterior processes; 16 dorsal vertebræ; caudal vertebræ numerous; lumbar processes small; decided hyperapophyses; scapula without a metacromion; no clavicles; no supra-condyloid foramen to humerus; ulna

Monatsbr. Akad. W. Berlin. 1865, p. 286. Wagner (Echinogale), *Schreb. Supplem.* II. p. 30 and 549, V. p. 585.

[1] Brandt, *Mem. de Petersb.* 1833, 6th series, II. F. Poey, *Memorias sobra la historia natural de la Isla de Cuba.* I. Habana, 1851, p. 23. Peters, *Abhandlungen des K. akad. der Wissen. zu Berlin.* 1864, p. 1, Pl. 1—3. De Blainville, *Insectivores*, p. 53, Pl. V. and IX. Owen, *Odontography*, Pl. CXI. fig. 1. Wagner, *Schreb. Supplem.* II. p. 79, V. p. 566.

[2] Prof. Allman, *Trans. Zool. Soc.* VI. p. 1, Pl. I. and II. Prof. J. V. Barboza du Bocage, 1ª *Classa da Academia* de 27 d'Abril, 1865. Lisbon, described under the name *Bayonia velox.* Peters, *Monatsbr. Akad. W. Berlin.* 1865, p. 286.

complete and distinct; scaphoid and semi-lunar bones separate; no os intermedium; pubic symphysis very small; tibia and fibula anchylosed together below; five digits to each extremity; no cœcum. *Habitat.* Old Calabar.

CHRYSOCHLORIDÆ[1].

I. $\frac{3-3}{3-3}$, C. $\frac{1-1}{1-1}$, M. $\frac{3-3}{3-3}$; skull very broad and high, tapering sharply forwards; greatest breadth between the posterior roots of the zygomata which are complete, and rather deep arches; no post-orbital process; occiput not sloping much forwards; premaxilla peculiarly produced; lambdoidal ridge traversing summit of cranium; no ridge or process in front of orbit; no ali-sphenoid canal; no pterygoid fossa; no paroccipital process; glenoid surface very small; ascending ramus of mandible very low, peculiarly truncated; coronoid process very low; a carotid foramen; a small glenoid foramen; sphenoidal fissure and foramen rotundum represented by one opening; infra-orbital foramen large and single; lachrymal foramen minute; true molars each in the form of a triangular prism; first upper incisor larger than the second; canine small; 19 or 20 dorsal vertebræ; cervical neurapophyses not very narrow antero-posteriorly; no cervical hypapophyses; spines of dorsal and lumbar vertebræ well developed; no hyperapophyses; no hypapophysial ossicles beneath the lumbar vertebræ; manubrium slightly keeled, but not much enlarged; clavicles long and very slender; humerus not very short; ulna complete and distinct; scapula broad, with a blunt metacromion; scaphoid and semilunar distinct; no sickle-shaped carpal ossicle or os intermedium; pelvis widely open below; tibia and fibula anchylosed together inferiorly; 4 digits to manus, 5 to pes; no cœcum; an ossified tendon in the fore-arm. *Habitat.* Southern and Eastern Africa.

CHRYSOCHLORIS. Lacépède.

M. $\frac{3-3}{3-3}$; a vesicular enlargement in the temporal fossa; lower molars without any posterior process.

CALCOCHLORIS. St G. Mivart.

M. $\frac{2-2}{2-2}$; no enlargement in the temporal fossa; lower molars with a marked posterior process.

TALPIDÆ.

C. $\frac{1-1}{\quad}$, M. $\frac{3-3}{3-3}$; cranium very broad behind, but not high;

[1] De Blainville, *Insectivores.* Pl. V. VII. VIII. and IX. F. Cuvier, *Dents des Mammifères.* No. XVIII. Owen, *Odontography.* Pl. CX. fig. 1. Wagner, *Schreb. Supplem.* II. p. 118, V. p. 579. Peters, *Reise nach Massambique.* p. 69, Tab. XXII.

tapering much, but gradually, forwards; greatest breadth behind the posterior roots of the zygomata, which are complete but exceedingly slender arches; occiput inclined much forwards; no post-orbital process; no ridge or process in front of the orbit; temporal fossa small; no ali-sphenoid canal; meso-pterygoid fossa not ending posteriorly in any excavation of the *basis cranii;* foramen magnum very large; no par-occipital or mastoid processes; glenoid surface small, and situated high up; no distinct post-glenoid process; ascending ramus of mandible not very low; supra-occipital enormous; generally a large pterotic; meatus auditorius externus opening decidedly below the glenoid surface; a carotid, but no glenoid foramen; foramen rotundum and spheno-orbital fissure represented by one opening; infra-orbital foramen very large; lachrymal foramen very small; molars above and below each formed of two triangular prisms; cervical neurapophyses very narrow antero-posteriorly; no cervical hypapophyses; spines of dorsal and lumbar vertebræ small; no hyperapophyses; autogenous hypapophysial ossicles beneath the interspaces of the lumbar vertebræ; manubrium keeled; scapula long and very narrow; radius and ulna distinct; an os intermedium; no symphisis pubis; tibia and fibula confluent below; 5 digits to each extremity; no cæcum. *Habitat.* Europe, Asia, including Japan, and North America.

TALPINA.

No distinct pterygoid fossa[1]; pterygoid region inflated; coronoid process not very elevated; spiculum of bone bounding infra-orbital foramen above, very narrow; as many as three incisors above; manubrium very elongated; clavicles very short and broad; no meta-cromion process; a sickle-shaped carpal ossicle. *Habitat.* Europe, Asia, North America.

TALPA[2]. Linnæus.

I. $\frac{3-3^{3}}{2 \text{ or } 3-3 \text{ or } 2}$, C. $\frac{1-1}{1-1}$, P.M. $\frac{4-4}{4-4}$, M. $\frac{3-3}{3-3}$; cranium very slightly constricted between the orbits; palate with no posterior thickening, but a small defect of ossification on each side; a very large pterotic; a fissure bordering epiotic; posterior palatine foramen large; anterior palatine foramen small; all the incisors very small; upper canine very elongated; lower canine small; posterior cusps of premolars very small; 5 or 6 lumbar vertebræ; caudal vertebræ few;

[1] I cannot be sure as to Condylura in this respect.

[2] De Blainville, *Ostéographie Insectivores.* Pl. I. V. and IX. F. Cuvier, *Dents des Mammifères.* No. XXII. Owen, *Odontography.* Pl. CX. fig. 3. C. Giebel, *Zeitschr. f. d. ges. Naturwiss.* Halle, Bd. 12. 1858. p. 395 to 405. Wagner, *Schreb. Supplem.* II. p. 106, V. p. 576.

[3] Since the above was written Mr C. Spence Bate, F.R.S. has proved by an examination of the young the correctness of Prof. Owen's formula. Abstract of a paper read at the Odontological Society of Great Britain, published in the *Annals and Mag. of Nat. Hist.* for June 1867.

ultimate phalanges of manus much the longest, bifurcating. *Habitat.* Europe and Asia.

CONDYLURA[1]. Illiger.

I. $\frac{3-3}{3-3}$, C. $\frac{1-1}{1-1}$, P.M. $\frac{4-4}{4-4}$, M. $\frac{3-3}{3-3}$; no fissure bordering epiotic; meatus auditorius with a very large external opening; muzzle much attenuated anteriorly; first and third upper incisors much larger than the second; upper canine very small; lower canine much larger than lower incisors; lower third incisor much smaller than the first or second; posterior cusps of premolars very large; 7 lumbar vertebræ; caudal vertebræ numerous; ultimate phalanges of manus not bifurcating. *Habitat.* North America.

SCAPANUS[2]. Pornel.

I. $\frac{3-3^{3}}{3-3}$, C. $\frac{1-1}{1-1}$, P.M. $\frac{4-4}{4-4}$, M. $\frac{3-3}{3-3}$; no fissure bordering the epiotic; cranium with a very slight inter-orbital constriction; palate not extending back beyond the last molars; first upper incisor much larger than the second or third one; the two upper posterior incisors, the upper canine, and first two premolars, all of nearly the same size; lower incisors, canines, and premolars, very gradually increasing in size from before backwards. *Habitat.* North America.

SCALOPS[4]. Cuvier.

I. $\frac{3-3}{2-2}$, C. $\frac{1-1}{0-0}$, P.M. $\frac{3-3}{3-3}$, M. $\frac{3-3}{3-3}$; cranium with a very marked inter-orbital constriction; no fissure bordering the epiotic; palate extending back beyond the last molars; first incisor very large, second and third minute; upper canine long and conical, and much more vertically extended than the first upper premolar; second lower incisor much larger than the first. *Habitat.* North America.

MYOGALINA.

A distinct pterygoid fossa; pterygoid region not inflated; no open fissure bordering epiotic; coronoid process very lofty; never as many

[1] De Blainville, *Insectivores.* Pl. I. V. and IX. F. Cuvier, *Dents des Mammifères.* No. XXII. bis. Wagner, *Schreb. Supplem.* II. p. 118, V. p. 574. S. F. Baird, *Mammals of N. Western America*, p. 71.

[2] Pornel, *Bulletin de la Soc. Géologique de France.* 1849. VI. S. F. Baird, *Mammals of N. Western America.* p. 58, Pl. XXX. Le Conte, *Pro. of Acad. of Philadelphia.* VI. p. 326. Bachman, *Journ. Acad. n. s.* Phil. VIII. 1839. 58. Wagner, *Schreb. Supplem.* V. p. 574.

[3] Prof. Peters considers that there are but four upper incisors.

[4] De Blainville, *Insectivores.* Pl. V. and IX. F. Cuvier, *Dents des Mammifères.* No. XXII. Owen, *Odontography.* Pl. CX. fig. 2. Giebel, *Zeitschr. f. d. ges. Naturwiss.* Halle, Bd. 12. 1858. p. 395—405. Wagner, *Schreb. Supplem.* II. p. 102, V. p. 571, 807. Baird, *Mammals of N. Western America.* p. 58, Pl. XXX. Bachman, *Boston Journal N. H.* 1843. IV. 28. Le Conte, *Pro. of Acad. of Philadelphia.* VI. p. 326.

as three incisors above[1]; first upper incisor longest tooth of upper jaw; manubrium not very large; clavicle and humerus elongated; a metacromion process; no sickle-shaped carpal bone.

MYOGALE[2]. Cuvier.

I. $\frac{2-2}{2-2}$, C. $\frac{1-1}{1-1}$, P.M. $\frac{5-5}{5-5}$, M. $\frac{3-3}{3-3}$; cranium with a very marked inter-orbital constriction; palate prolonged beyond the last molar; its posterior margin thickened; a large perforation in each exoccipital; anterior palatine foramen very large; infra-orbital foramen bounded above by a broad spiculum of bone; the *very* small lachrymal foramen opens at the anterior side of the upper end of the spiculum; first upper incisor the largest and longest of all the teeth; second upper incisor very small; cervical neurapophyses mere filaments; many caudal vertebræ; pes rather, or very, elongated, both absolutely, and compared to manus. *Habitat.* Eastern and Western Europe.

UROTRICHUS[3]. Temminck.

I. $\frac{2-2}{1-1}$, C. $\frac{1-1}{1-1}$, P.M. $\frac{4-4}{4-4}$, M. $\frac{3-3}{3-3}$; lachrymal foramen immediately above the middle of the infra-orbital foramen; no large exoccipital perforation; infra-orbital foramen bounded above by a very slender spiculum of bone; second upper incisor of considerable size, though not nearly so large as the first incisor; few caudal vertebræ; pes not elongated. *Habitat.* Japan and Western N. America.

SORICIDÆ, SOREX[4]. Linnæus.

$$\text{I. } \frac{4-4}{1-1},\ \text{C. } \frac{1-1}{1-1},\ \text{P.M. } \frac{2-2}{1-1},\ \text{M. } \frac{3-3}{3-3},$$

$$\text{or I. } \frac{3-3}{1-1},\ \text{C. } \frac{1-1}{1-1},\ \text{P.M. } \frac{2-2}{1-1},\ \text{M. } \frac{3-3}{3-3},$$

$$\text{or I. } \frac{3-3}{1-1},\ \text{C. } \frac{1-1}{1-1},\ \text{P.M. } \frac{1-1}{1-1},\ \text{M. } \frac{3-3}{3-3},$$

$$\text{or I. } \frac{2-2}{1-1},\ \text{C. } \frac{1-1}{1-1},\ \text{P.M. } \frac{1-1}{1-1},\ \text{M. } \frac{3-3}{3-3};$$

[1] Possibly there may also be only four upper incisors in *Scalops* and *Scapanus*.

[2] J. F. Brandt, *Archiv fur Natur.* 2 Jahrg. 1836. I. p. 176. Geoff. *Mem. du Mus.* I. Tab. XV. figs. 10—12. 1815. De Blainville, *Insectivores.* Pl. II. V. and IX. F. Cuvier, *Dents des Mammifères.* No. XXI. Wagner, *Schreb. Supplem.* II. p. 95, v. p. 567.

[3] Temminck, *Fauna Japan.* I. p. 22, Tab. IV. fig. 6—11. Wagner, *Schreber Supplem.* v. p. 569. Spencer F. Baird, *Mammals of Western N. America.* p. 76. Pl. XXVIII.

[4] De Blainville, *Insectivores.* Pl. II. V. and X. F. Cuvier, *Dents des Mammifères.* No. XX. Owen, *Odontography.* Pl. CX. fig. 4. Duvernoy, *Magasin de Zoologie.* 1842. Wagner, *Schreb. Supplem.* I. p. 47, v. p. 539 and 802. Dr E. Brandt, *Russian Memoir of* 1865, before referred to. Spencer F. Baird, *Mammals of Western N. America.* p. 7—56.

cranium broad behind, tapering forward; greatest breadth behind the glenoid surfaces; no post-orbital process; occiput sloping much forwards; no pterygoid fossa; no zygoma; pterygoid region not inflated; meso-pterygoid fossa ending posteriorly in no excavation of the *basis cranii;* no ali-sphenoid canal; a large aperture on each side of the base of the skull; large and antero-verted post-glenoid processes; foramen rotundum and sphenoidal fissure represented by one opening; infra-orbital foramen considerable, limited above by a thick bar of bone; inside of ascending ramus of mandible with a peculiar and deep excavation; articular surface of condyle looking backwards; angle very attenuated; first incisor much larger than the others, and always with 2 cusps; upper canine always smaller than the smallest upper incisor; upper molars with two triangular prisms; lower incisor very elongated; lower canine smallest tooth of mandible; 13 to 15 dorsal vertebræ; 5 or 6 lumbar vertebræ; large cervical hypapophyses; no lumbar hypapophysial ossicles; well-marked hyperapophyses; manubrium broad, but not keeled; clavicle small and slender, not joining humerus; scapula short and broad; a bifurcating acromion process; generally a supra-condyloid foramen in humerus; radius and ulna distinct; no sickle-shaped bone or os intermedium in carpus; ultimate phalanges not bifurcating; pelvis narrow, symphysis widely open; femur with a third trochanter; tibia and fibula confluent below; 5 digits to each extremity; no cœcum. *Habitat.* The Old World, and N. America.

REVIEWS AND NOTICES OF BOOKS.

UNTERSUCHUNGEN ZUR VERGLEICHENDE ANATOMIE DER WIRBELTHIERE (Researches on the comparative anatomy of vertebrates) von Dr Carl Gegenbauer, professor of anatomy in Jena, erstes Heft—Carpus und Tarsus; zweites Heft—Schultergürtel der Wirbelthiere und Brustflosse der Fische. Leipzig, 1864–5.

THE object of the first two of these admirable memoirs is to give a systematic comparative account of the respective parts (the carpus, tarsus, and shoulder-girdle) in the vertebrate series. With regard to the carpus and tarsus the author commences with the tailed Amphibians, in which, or some of them, these parts present a simple and regular structure, each consisting of nine cartilaginous pieces, arranged in two rows, with a central piece between the two, the several pieces having plain surfaces adapted, mosaic-like, together, and capable therefore of little movement upon one another. He then traces through the higher members of the vertebrate series the several modifications and deviations from this simple form, which are due to variations in size and shape, to coalescence of two or more into one, and to the failure of development of one or more.

Thus the CARPUS consists in these Amphibians of three pieces (*radial*, *ulnar*, and *intermediate*, i.e. 'scaphoid,' 'cuneiform,' and 'semilunar') in the first row, of five pieces (1st, 2nd, 3rd, 4th, and 5th *carpals*, i.e. 'trapezium,' 'trapezoides,' 'magnum,' and 'unciform,' the latter representing *carpals* 4 and 5) in the second row, each bearing its metacarpal, and of a *central* piece surrounded by the others, and, in some few instances, in contact with them all. This number and order is retained pretty generally in the five-toed Amphibians and in Reptiles, sometimes, with a 'supernumerary' piece, as in the ulnar side of the second row in the Turtle, or, on both sides, in Emys; or two pieces may become united, as the *radial* and *central*, and the 4th and 5th *carpals* in Emys. The diminution in the number of the digits is usually attended with a corresponding diminution in the number of the carpal pieces. In the Croco-

dile, however, there are only the *radial* and *ulnar* in the first row; and the members of the second row are reduced in number, in size, and in ossification. This form therefore, he regards as conducting us to the carpus of the bird, in which the second row is absent, and the first is represented only by the *radial* and *ulnar*. In Mammals there is a nearer return to the type as regards number; though the forms (except in ordinary cetaceans) are very varied, each bone presenting distinctive features. Some of the pieces lose their individuality, as the 4th and 5th *carpals*, usually forming the 'unciform,' and the *radial* and *intermediate* forming the 'scapho-lunar' in carnivora. The *centrum* is absent, except in Rodents and some Apes. This bone is not a detachment from the scaphoid or the magnum, but a reappearance of the central piece of the reptilian carpus.

The results of the investigations of the TARSUS, conducted in the same manner, are still more interesting and important. In the tailed Amphibians, or some of them, the pieces are disposed as in the carpus, viz. three (*tibial*, *fibular*, and *intermediate*) in the first row, five (*tarsals*) in the second row, and the *central* surrounded by the others, but belonging rather to the first than to the second row, all with flat opposed surfaces. The chief modifications are, besides the variety in the contour of the surfaces; *first*, a reduction in the number of the first row; the *tibial* and *intermediate* forming the astragalus, with which the *central* is united in the Crocodile and some Tortoises, and in addition the *fibular* in others; so that the one proximal bone in the tarsus of Emys is the representation of the four pieces of the Salamander. *Secondly;* this one proximal piece in the Lizards (Iguanas, Monitors, &c.) is closely, almost immoveably, connected with the tibia and fibula, and the movement of the foot is chiefly effected in the tarso-tarsal joint, that is, between the components of the first and second tarsal rows. We are thus prepared for the condition of the Bird. Here, the representatives of the proximal row are not, as usually supposed, absent, but united to the lower end of the tibia, forming a 'tibiotarsal' bone; while the representatives of the distal row are united with the metatarsals forming the 'tarso-metatarsal' bone; and the joint, accordingly, is not between the latter and

the tibia, but between the two rows of the tarsus, and is, therefore, a tarso-tarsal joint.

The proximal element of the tarsus, thus regarded by the author as united with the lower end of the leg-bones, requires, we think, to be more clearly distinguished from their epiphysis before this view can be fully accepted. A cartilaginous piece with one or two osseous nuclei exists here in connection with leg-bones. It has hitherto usually been assumed to be the epiphysis of those bones. If it be, as the author maintains, the representative of the first tarsal row, then the epiphysis is wanting, its place being supplied by the tarsal series. That is to say, either the epiphysis or the first row of the tarsus is absent; and it is rather a nice point to determine which is the absentee, especially as there is usually an epiphysis at the upper end of the tibia. The comparative infrequency of epiphyses in birds is a point in favour of the author's views, which further derive much support from his observation, that the cartilaginous piece referred to is not originally a part of the tibia, but is, at first, separate, and subsequently coalesces with the cartilage of the tibia.

In the Mammalian tarsus, Gegenbauer regards the 'astragalus' as the representative of the *tibial* and the *intermediate* of the amphibian, and as corresponding therefore with the 'scaphoid' and 'semilunar' ('the scapho-lunar' of the carnivora) in the carpus. The central position of the scaphoid, between the two rows of tarsal bones, shows it, he thinks, to be the representative of the *central* piece of the amphibian.

The comparative description of the SHOULDER-GIRDLE is very exhaustive. The conclusions are drawn much from development. He finds the shoulder-girdle to consist, on each side, of two parts; a *primary* part formed of one continuous piece of cartilage, by the ossification of which commencing at separate points the 'scapula,' 'supra-scapula,' and 'coracoid' are differentiated; and a *secondary* part, separate from the former, resulting mainly from membranous ossification which constitutes the clavicle. True, there is a cartilaginous basis for the latter in Mammals and Birds, but it is slight, the formation of bone in it is by direct calcification, not by the process observed in other

cartilaginous bones, and no cartilaginous basis appears to exist in the lower vertebrate classes. The clavicles of the two sides are connected by more or less distinct 'episternal elements.' An offset from the coracoid forms the 'procoracoid' or anterior ventral process of the Chelonians and the Lizards: the intervening space is converted into a 'fenestra' by a membranous or cartilaginous bond of union between the ends of the two processes; and a separate ossification may take place in it.

The absence of sufficient connecting links forbids a close comparison of the shoulder-girdle and pectoral fin of fishes with the corresponding parts in the higher vertebrates. Gegenbauer finds the typical piscine form in the girdle and fin of Sharks and Rays, deduces the various forms of the different members of the class from this, and shows to what extent the component parts present homologous affinities with those of the typical (amphibian), and so of the other forms of the upper vertebrate classes.

TOPOGRAPHISCH-ANATOMISCHER ATLAS NACH DURCHSNITTEN AN GEFRORNEN CADAVERN herausgegeben von Dr W. BRAUNE, Professor an der Universitat, Leipzig; erste Lieferung. Leipzig, Veit und Co.

These are lithographic representations of sections made with a fine saw of a body which had been thoroughly frozen by immersion for three days in a mixture of ice and salt so as to preserve a temperature of -15° R., thus ensuring, perhaps, better than in any other way, correct drawings of the parts in situ. The structures are well delineated, the colouring is good; and the plates will prove serviceable both to teachers and students.

KUEHNE, UEBER DIE VERDAUUNG DER EIWEISZSTOFFE DURCH DEN PANCREASSAFT (On the Digestion of Proteids by the Pancreas), von Dr W. KUEHNE. Virchow, *Archiv*, XXXIX. 130. (Besonders abgedrückt).

KÜHNE's investigation began as an attempt to settle the long disputed question of the action of Pancreatic juice on Proteids; but the above pamphlet refers chiefly to the action of pancreatic infusion or rather of the pancreas itself.

A large dog was bled to death, after having been well fed on horse-flesh six hours and also eighteen hours before. The pancreas, after the fat about it had been carefully removed, was washed as free as possible from blood with cold water, finely minced, and at once thrown into the warm water already containing the substance to be digested. This latter consisted of white, well washed, well boiled fibrin of bullock's blood. In this way 55 grammes of Pancreas (=15·2 grms. of dry gland substance) were mixed with 400 grms. of boiled and pressed fibrin (= 382 grms. fibrin dried at 110° C) in 6 litres of water and exposed with frequent shaking to a temperature of 40 – 45° C. It was found from numerous trials most convenient to use the material in these proportions.

The reaction of the mixture was faintly alkaline and remained so during the whole of the experiment, which lasted about six hours. By this time nearly the whole of the fibrin and pieces of pancreas had disappeared. The undissolved residue was removed, the fluid freed from albuminates, &c. by acidulation and boiling, the pepton precipitated by a profuse use of alcohol of 95 per cent. and the alcoholic filtrate evaporated down. From this concentrated filtrate Kühne obtained very remarkable quantities of tyrosin and leucin, and the mother liquor, after removal of these bodies by crystallization, contained a substance which treated with chlorine water or calcic chloride gave rise to a deep dark violet colour due to almost black flakes swimming in a rose-red fluid.

Thus 382 grms. dried fibrin + 15·2 grms. dried pancreas = 397·2 dried Proteids (chiefly) upon 6 hours digestion at 40 – 45° C, gave 11·0 grms. undissolved residue + 42·5 albuminates, &c. = 53·5 grms. of undigested substance.

There was a disappearance therefore of 343·7 Proteids, in place of which were obtained 211·2 grms. Pepton, 13·3 grms. Tyrosin, 31·6 grms. Leucin = 256·1 grms., leaving 87·6 grms. unaccounted for.

This experiment and repetitions of it led to several important conclusions.

1. Alkaline pancreatic infusion (the pancreas being removed from an animal during digestion) will not only digest proteids but will digest them at a rate and to an extent compared with which gastric digestion seems a slow and feeble process. It takes the collected ferment of a whole stomach days to digest half the amount of fibrin which the pancreas will digest in as many hours.

2. The pepton produced by the action of pancreas, the pancreas pepton, differs in no essential respects from gastric pepton. Its neutral solution (and it is exceedingly soluble in water) is highly diffusible, is not coagulated by heat, and gives the ordinary proteid reactions. It differs chiefly from gastric pepton in the precipitate with acetate of lead not being redissolved in an excess of the reagent as is the case with the latter; but even this mark appears uncertain. It certainly agrees exactly neither with the *a*, *b* nor *c* pepton of Meissner; but pepton prepared by Kühne from fibrin by means of pig's stomach exhibited the same want of agreement.

3. Perhaps the most striking fact in the experiment is the enormous production of tyrosin and leucin[1]. Kühne even goes so far as to recommend pancreatic digestion as the most convenient method of preparing tyrosin. We seem to see here the reason why tyrosin and leucin are so often found in pancreas and sometimes in pancreatic juice; they arise from self-digestion. Thus a pancreas of a dog weighing 47 grms., minced and boiled immediately after removal from the body, gave a decoction containing a trace of pepton, not even an indication of tyrosin and only minute quantities of leucin. Another pancreas of 53 grms. minced, and left to itself for 3 hours in 1 litre of water gave abundance of pepton, much tyrosin and still more leucin. That however in the experiment of fibrin digestion neither leucin nor tyrosin came from the pancreas alone is shewn by the fact that the tyrosin obtained weighed nearly as much and the leucin more than twice as much as the dry weight of the pancreas used.

According to these experiments, therefore, digestion (at least pancreatic digestion) is not a mere conversion of proteids into diffusible modifications, but a process of actual destructive decomposition. We learn from Thiry's analyses that pepton has about the same elementary composition as undigested proteid; and hence it is extremely unlikely that the change taking place in digestion consists in the splitting up of fibrin, for example, into pepton on the one hand and into leucin, tyrosin, &c. on the other. A much more probable idea is the one that pepton is a stage of decomposition; that the whole of the proteid undergoing digestion is changed first of all into pepton, which is afterwards split up into various non-proteid bodies. This view is further supported by the following experiments.

Kühne found that pancreatic infusion, though most active in an alkaline state, would also digest when acid, provided that the acidity was very feeble. Availing himself of the opportunity afforded by the use of an acid of prolonging the process of pancreatic digestion without fear of so-called putrefactive decomposition, he exposed 382 grms. of dried fibrin to the action of pancreas (dry weight 14·6 grms.) for 24 hours in 6 litres of water, and obtained

Pepton 24·5, tyrosin 0·63, leucin 4·77, unknown products 60·10 per cent. When these results are compared with those of the original experiment of 6 hours duration, which gave

Pepton 61·45, tyrosin 3·86, leucin 9·20, unknown products 25·49, per cent. it will be seen how great was the destructive action of the prolonged process. A similar result was obtained when digestion was intensified rather than prolonged by the addition of an alkali. Thus 382 grms. acted upon by a pancreas (dry weight 16·2 grms.) in 6 litres of water and 9 grms. of dried soda for 10 hours, gave

Pepton 8·0, tyrosin 1·0, leucin 3·0, unknown products 87·2 per cent.

The vile stenches which accompanied this interesting experiment, and which drove every one out of the laboratory in which it was being

[1] This seems to have been previously observed by Skrebitzki. See Fudakowski, *Med. Centralblatt*, 1867, p. 547.

conducted, fully justified its being called an experiment of artificial fæcification; a fact not unworthy of notice.

There are many persons who when they had called experiments such as these mere processes of putrefaction, would feel satisfied that they had made the matter clear to themselves at least. To those who are not so readily satisfied with large words of indefinite meaning, it may be important to know that in none of these mixtures could any living organisms be detected by the most careful microscopic scrutiny.

This production of leucin and tyrosin by means of digestion (i.e. pancreatic digestion, for Kühne was unable to detect them in gastric digestion) naturally calls to mind the occurrence of those bodies in putrefying bodies containing proteid matters, for instance, in cheese; and the ordinary means of preparing tyrosin and leucin is by the destructive oxidation of proteid and other nitrogenous colloids. Kühne has made the very interesting observation that when fibrin is exposed to the action of dilute sulphuric acid and the process interrupted before much tyrosin or leucin have been formed, a veritable pepton may be obtained from the mixture. When the action of the sulphuric acid has continued for some time, this pepton is no longer to be found.

It need hardly be remarked, that these experiments of Kühne place digestion in a somewhat different light from the one which is at this moment predominant, and are exceedingly suggestive in many ways. The loss of nutritive material through the generation of what are generally regarded as products of regressive metamorphosis indicates the possibility of a *luxus* consumption of nitrogenous food, very different from the luxus consumption of Bidder and Schmidt. At the same time if, as is possible, the greater part of the pepton escapes into the blood by diffusion almost as soon as it is formed and before it has had time to undergo any further changes, giving rise to leucin, &c., it is evident that natural digestion in the live alimentary canal must after all lead to results very different from those which follow upon artificial digestion taking place in the glass vessels of the laboratory.

M. F.

HERING AND KÖLLIKER, ON THE MINUTE ORIGIN OF THE BILE-DUCTS.

KÖLLIKER in a letter to Dr Sharpey (dated May 1867) states that recent observations of his own have led him to adopt Hering's views concerning the origin of the bile-ducts, and have enabled him to bring forward some new facts in support of them. In order to make Kölliker's remarks intelligible, I venture to give a brief description of Hering's researches. As is well known, the views of Dr Beale, which for a long time were accepted by most anatomists, have of late years been placed in doubt through the investigations of Frey, Budge, Andrejevic, Mac Gillavry and others, who succeeded in filling with injection, through the bile-ducts, minute anastomosing passages, running in various directions among the hepatic cells and enclosing them in a fine

network. Many persons are very naturally unwilling to trust much to appearances presented by artificially injected specimens, in which it is so easy to be deceived by what are really extravasations though they often appear to be disposed with great regularity. Objections of this kind may however be considered to have been fully met by the experiments of Chrzonszczewsky, who by his method of natural injection with sulphindigotate of soda brought to light minute anastomosing canals permeating the substance of the lobules and exactly similar to those which had been produced by forcibly driving injection-material backwards through the bile-ducts.

That these passages exist in a natural state and form a veritable element of the hepatic structure can now hardly be doubted; but the question arises what is their nature, with what other passages are they homologous, and what relation do they bear to the hepatic cells? If they are ducts they ought to have an epithelium; but they have none, not so much even as an indubitable *membrana propria*, though Mac Gillavry and Chrzonszczewsky have described hanging to the minute masses of injection-material in torn specimens, shreds which they imagine to be remnants of parietes. If again they are complete though minute ducts, what are the hepatic cells lying outside them? Are we to return to a modification of Dr Handfield Jones's view and imagine each lobule of the liver as a ductless gland riddled with thin anastomosing biliary passages?

Hering (Max Schultze's *Archiv*, III.) found the liver of the snake a very instructive study. In this animal, by means of injections of soluble Berlin blue (see this *Journal*, Vol. I. p. 369) it is easy to see that the liver is really made up of a multitude of anastomosing tubules, enveloped by the meshes of the blood-capillaries, and lined by an epithelium whose large granular cells with conspicuous nuclei fill up nearly the whole cavity of each tubule, only a small thread-like sinuous central canal being left. There is no difficulty here. The tubules form the secreting portion of a large multifid anastomosing biliary gland called the liver: as in other glands, the epithelium of the proper secreting portion differs in character from that of the mere conducting portion, and puts on the features which we recognize as those of hepatic cells; and the blood capillaries are separated from the canals of the tubules by the width of at least one secreting cell.

In the mammalian liver, as for instance in the rabbit's liver (which is well adapted for these studies), the structure though at first sight apparently entirely different, is seen upon examination to be fundamentally the same. The difference really amounts to this;—that while in the snake 3, 4 or more cells, uniting in a circle, leave a central space to form the biliary channel, in the rabbit 3, 4 or more biliary channels are, in part, bounded by a single cell. This singular state of things is believed by Hering to be effected in the following way. Mac Gillavry and others imagined that the distribution of these minute bile-capillaries, as they have, unfortunately we think, been called, bears no definite relation to that of the blood-capillaries. Hering, however, believes that there is a very fixed

relation between them of the following kind. Let the hepatic cell be imagined to be represented by a large solid cube (the natural form is of course not exactly cubical) and, as it stands, for instance on a table, let a wide gouge be carried vertically down each corner from the top to the bottom, and a much finer gouge be carried vertically down the middle of each side. If a number of cubes thus treated were crowded together on the table touching each other side to side, it is evident that large rounded gaps would be left at the corners of the cubes, while the small grooves on the sides would fit with the corresponding grooves of adjacent cubes and so form narrow channels. A model would thus be obtained of a section of hepatic substance, the large gaps representing the spaces occupied by the blood-capillaries and the narrow grooves the minute biliary passages. The blood-vessels run along the angles or corners of the hepatic cells while the biliary passages occupy the centres of the sides. One has only to imagine the biliary grooves carried across the top and bottom of the cells as well as down the sides, to think of several cells placed one upon another so as to form the well-known rows enclosed in elongated vascular meshes, to convert the cube into a decahedron or dodecahedron, and to allow for numerous variations, and the hepatic structure is at once understood.

The minute biliary passage being then a groove between two hepatic cells, these constitute its real epithelium, and there is no need to look for any further epithelium or parietes. Hering denies that these ducts have any distinct parietes, but he seems to admit that the hepatic cells have a distinct cell-wall; and Eberth (*Centralblatt*, 1866, no. 57) is probably right when he asserts that the cell-wall receives a special cuticular thickening just where the grooves are situate. Fragments of this cuticula may possibly have given rise to the appearance of distinct parietes referred to above. It is needless to add that these groove-formed channels may be traced into the interlobular bile-passages, their (hepatic) epithelium gradually, and yet more or less suddenly, suffering change of character into ordinary epithelium. And it is evident that, by means of this peculiar disposition of blood- and bile-capillaries, as much (secreting) cell-substance as is possible under the circumstances is placed between the blood-current and the biliary passage.

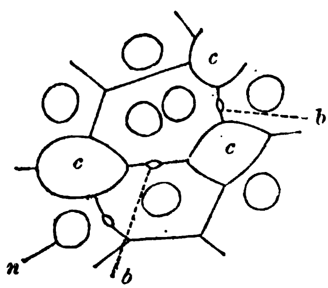
Kölliker states that from an inspection of Hering's specimens he has become convinced of the truth of that anatomist's views. He believes that Hering's sections of injected liver shew that these minute biliary passages not only exist, but are *bona fide* fine gall-ducts continuous with the larger and more obvious ones, and that they bear to the hepatic cells and to the blood-capillaries the relative position we have just described. He has also prepared injections of his own shewing the same things (Fig. 1); and what is entirely new and especially worthy of notice, he has had the good fortune to see in a section of *uninjected* rabbit's liver distinct evidence of the biliary passages. He observed in the line of junction of hepatic cells lying side by side small lenticular cavities exactly corresponding in size

and position with the minute spaces, which Hering inferred must exist between the hepatic cells, as sections of the channels along which his injection material passed. The appearance of such a minute cavity is indicated in fig. 2. *b*.

Taken in conjunction with Hering's researches these observations of Kölliker are very valuable. They afford a corroboration of Hering's views on the existence, nature, and disposition of these minute passages which could not be obtained by any method of injection.

Method. Hering prepares a concentrated solution of soluble Berlin blue, and by means of a special apparatus, a description of which he is about to publish, injects it, without any gelatine, through the gall-bladder immediately after death, while in fact the part is still warm and living, the ductus communis having been previously ligatured.

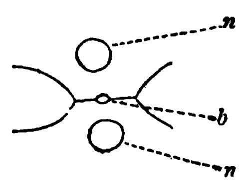
Fig. 1.



Section of a rabbit's liver, injected.
c. blood capillaries.
b. bile passages.
n. nucleus of hepatic cell.

He afterwards injects carmine and gelatine through the blood-vessels. The liver is hardened in alcohol; and thin sections may be cleared with glycerine, or treated with kreosote and put up in Dammara or Canada balsam. He finds it better to be contented with a tolerably intense local injection than to attempt to drive the material into the whole liver.

Fig. 2.



Rabbit's liver, uninjected. Junction of two hepatic cells.
n. nucleus.
b. cut end of bile passage.

M. F.

REPORT ON THE PROGRESS OF ANATOMY.

By Professor Turner[1].

Osteology.—The observations of M. W. Koster (*Annales des Sciences Nat.* T. vii. 1867, p. 122), on the Morphological Signification of the Occipital Bone, atlas and axis, have led him to the following conclusions. 1st, the oblique processes are defective at the upper part of the arch of the axis, and completely wanting at the posterior arch of the atlas. 2nd, the superior articular facets of the axis and inferior of the atlas ought to be regarded as the lateral parts of the body of the vertebra. 3rd, the superior articular surface of the atlas and the occipital condyle are formed partly of the lateral portion of a body of a vertebra, partly by the neighbouring portion of the arch. 4th, the anterior arch of the atlas ought to be considered as analogous to the hæmal arch in the lower vertebrata. 5th, the union of the odontoid process with the basi-occipital, is in mammalia, as in birds and reptiles, due to an upward prolongation of the body of the vertebra. 6th, vertebræ are always united by parts of the same nature. The modifications presented by the union of the atlas, odontoid process, and occiput, in the animal series and in man are in relation to this law. The Reporter may also refer to the essay by Professor Cleland (*Nat. Hist. Rev.* April, 1861), in which it is shown that the articular surfaces of the atlas and the superior pair of the axis are not serially homologous with the oblique processes of the vertebræ below.—Dr Macalister records several Abnormalities in the skeleton of the Upper Limb (*Medical Press and Circular*, 1867), one of the most interesting of which is a case of supernumerary carpal bone situated on the back and upper part of the head of the os magnum, between it and the scaphoid. It has one small and three large surfaces; one articulates with the radius, another for the scaphoid, a third for the os magnum, and a fourth, rough and cancellous, joins the lunar.

Myology.—Amongst recent contributions to Human Myology, is a paper by Dr Törnblom (*Medicinskt Archiv*, Stockholm, 1865), in which he describes the existence of a *musc. transversalis cervicis medius* lying between the scalenus medius and posticus: arising from the transverse processes of the 2nd, 3rd, and 4th cervical vertebræ, and inserted below into the transverse processes of the 6th and 7th cervical vertebræ. It is largely developed in the cat, dog, rat, &c. Very frequently small fascicles belonging to the multifidus spinæ proceed from the lower margin of the laminæ of the 5th and 6th cervical vertebræ to the neck of the 1st and 2nd ribs, and sometimes similar fascicles proceed to other ribs. Sometimes a small muscle passes from the anterior part of the transverse process of the 7th cervical vertebra to the capsule of the 1st costo-vertebral joint; and sometimes

[1] In order to assist in making this report more complete, Professor Turner will be glad to receive separate copies of original memoirs and other contributions to Anatomy.

one proceeds to the outer surface of the cervical part of the pleura, in which case the nerves lie behind and the artery in front of the muscle. He states that there is no levator costæ muscle from the transverse process of the 7th cervical vertebra to the first rib, and that the scalenus medius is substituted for it. He describes a case of a child in which the first pair of chondro-sternal joints were true capsular articulations, and their cavities were subdivided into an upper and lower part by a fibrous interarticular ligament; also a case in which a fibrous band was substituted for a portion of the 1st right costal cartilage.—F. Merkel (*Henle's Zeitschrift*, Vol. 29, p. 158, 1867), describes a case in which a muscular slip arising along with the left pectoralis major from the 6th rib, passed across the axilla, divided into two bundles, and joined a musculo-tendinous band, which arose from the latissimus-dorsi and passed in front of the axillary vessels and nerves to end in the tendinous origin of the coraco-brachialis. It resembled in many respects a slip described by the Reporter in our May number, note 1st, p. 252. Prof. Wenzel Gruber describes (*Mémoire de l'Académie de St Pétersbourg*, Vol. x. April, 1866), under the name of MUSCULUS EPITROCHLEO-ANCONEUS, a muscle which occurred in 34 per cent. of the subjects examined, and is indeed the most frequent anomaly met with in the muscles of the upper limb. It lies at the inner elbow, superficial to the ulnar nerve, by which it is supplied. It arises from the internal condyloid eminence, and is inserted into the olecranon either alone, or along with the tendon of the triceps. He then describes the existence of this muscle in many of the mammalia.—F. E. Schulze gives an account (*Siebold u. Kölliker's Zeitschrift*, Vol. XVII. p. 1, 1867) of the CONNECTION OF THE TENDONS of the flexor longus hallucis and fl. long. digitorum in the feet of man and many mammals, but as his results have been incorporated by Prof. Humphry in his paper on the Chimpanzee in the last number of this Journal, we need not further report them.—Reference may also be made to the myological contributions of Prof. Turner on the MUSCULUS STERNALIS, Dr Macalister ON THE MUSCLES OF THE SHOULDER, and Messrs. Murie and Flower ON THE DISSECTION OF A BUSHWOMAN, in our May number.—Mr John Wood contributes a third series of VARIATIONS IN HUMAN MYOLOGY (*Proc. Roy. Soc. London*, May 23, 1867) made on 36 subjects. He figures the epitrochleo-anconeus muscle above referred to as described by Gruber, and supplies much additional information on muscular variations.—Prof. W. Gruber communicates (*Mém. de l'Acad. Imp. de St Pétersb.* June, 1866) an important monograph on the BURSÆ MUCOSÆ of the upper limb, in which he not only considers the observations of previous writers but describes the following new bursæ; *bursa musculi brachialis interni* between the brachialis anticus and coronoid process; *bursa retro-epitrochlearis* beneath the anconeus internus and ulnar nerve; *bursa m. flex. digit. sublimis* in relation to the tendon of origin of the superficial flexor from the condyle: and a small bursa which lies under the insertion of a few fibres which constitute the *tensor ligamenti annularis radii anterioris* muscle.

Dr J. B. Pettigrew states that the arrangement of the fibres in the MUSCULAR WALL OF THE STOMACH in man and other mammalia (*Proc. Roy. Soc. London*, June 20, 1867) resembles that which he has already described in the heart and bladder. That the most external and internal fibres are more or less longitudinal, and that the deeper or more central fibres become more and more oblique, as the centre of the parietes is reached. The longitudinal intersect the very oblique at nearly right angles, the slightly oblique and oblique at more acute angles. All the oblique fibres are spiral, and form, or tend to form, figure of 8 loops, which are directed towards the curvatures of the stomach, but are also traceable on the great cul-de-sac and the antrum pylori: the roots of the esophagus and pylorus are consequently invested with oblique spiral fibres, arranged systematically in two sets, which pursue opposite directions and surround the esophageal and pyloric orifices like sphincter muscles. Fibres cross and loop also on the body of the viscus, so that the so-called circular layer is really composed of very oblique spiral fibres intersecting at very obtuse angles. He considers that there are indications of 7 layers of fibres, 3 internal, 3 external, and 1 intermediate, but he uses the term layer in a more restricted sense than in his former papers on the heart and bladder, and now admits that there is a mutual interchange of fibres between the different layers.—M. L. Mitrā has published a pamphlet ON THE ULTIMATE STRUCTURE OF MUSCULAR TISSUE, and the mode of ending of motor nerves (Edinburgh, 1867), in which he states that the prevalent views on the subject are erroneous; that the ultimate fibres consist of two essential structures, one a flat thread of contractile tissue, the other a network of fine nerves, having the appearance of striæ, situated upon the former. He has "a long tale to tell of the binde-gewebe of Professor Virchow, but postpones it for the present."—C. Eckhard (*Henle's Zeitschrift*, Vol. XXIX. p. 55, 1867) records his OBSERVATIONS ON THE DEVELOPMENT OF THE MUSCULAR FIBRES OF THE HEART; and F. N. Winkler (*Reichert u. du Bois Reymond's Archiv*, p. 221, 1867) communicates observations on the SARCOLEMMA, AND SUBDIVISION OF THE FIBRES OF THE SAME ORGAN.

NEUROLOGY.—O. Fraentzel contributes some observations on the STRUCTURE OF THE CELLS OF THE SPINAL AND SYMPATHETIC GANGLIA (*Virchow's Archiv*, April, 1867, p. 549), which were made principally on guinea-pigs and rabbits. The cells of the spinal ganglia lie in an envelope of convective tissue continuous with the neurilemma of the nerves. He has never been able to trace more than one opaque-bordered nerve fibre to a cell; often through the cell substance as far as the nucleus. He has seen spiral fibres also in the spinal ganglion of a human embryo, but has found no evidence of their nervous nature. He believes that the capsule enveloping each spinal ganglion cell is lined by a single layer of polygonal, large, nucleated, tesselated, epithelium cells. Observations on the capsules of the sympathetic ganglion cells lead to similar conclusions.—Dr Rüdinger (*pamphlet, Munich*, 1866) describes his dissections of THE CONNECTION of the thoracic por-

tion OF THE GANGLIATED CORD OF THE SYMPATHETIC WITH THE INTERCOSTAL NERVES. He figures the communicating branches which connect the spinal and sympathetic nerves together in this region. He considers that the roots of the splanchnic nerves are mainly derived from the intercostal nerves; which roots run for some distance along with the sympathetic cord, and then leave it to join and form the splanchnic. About four-fifths of each splanchnic nerve being derived from the spinal and only one-fifth from the sympathetic system. The great splanchnic nerve receives roots from the 2nd to the 9th intercostal nerves inclusive: the small splanchnic nerve from the 10th, 11th and sometimes from the 9th intercostal nerve: the third or renal splanchnic nerve from the 12th intercostal and 1st lumbar spinal nerves.—In an essay on the structure of the mucous membrane of the tongue, Freyfeld-Szabadföldy (*Virchow's Archiv*, Febr. 1867, p. 177) describes the MODE OF TERMINATION OF THE NERVES IN THE PAPILLÆ.

BLOOD-VESSELS.—Hermann Oeffinger describes the case (*Virchow's Archiv*, July, 1867, p. 424) of a child in which the ARTERIES OF THE FORE-ARM possessed a variation in arrangement. The left brachial artery gave off the radial opposite the insertion of the coraco-brachialis tendon, and divided just below the elbow into common interosseous and ulnar branches. The ulnar at the middle of the ulnar side of the fore-arm divided into two equal branches, which passed to the palm; one superficial to the flexor sublimis gave off digital branches to the radial side of the index and middle, and the ulnar side of the index and thumb, the other supplied digital branches to the little, ring and ulnar side of the middle finger, and joined the deep palmar arch. On the right side the Art. magnæ pollicis and indicis arose from the ulnar.—Wenzel Gruber relates (*Reichert und Du Bois Reymond's Archiv*, Part II. p. 256, 1867) two cases, out of between 80 and 100 embryoes and children examined, in which the left innominate vein passed through the thymus gland; the left lobe being in front of, and the right lobe behind the vein.

BLOOD CORPUSCLES.—In the *Microscopical Journal*, April, 1867, p. 127, Professor Rolleston notes the occasional occurrence of one or more nuclei irregularly and eccentrically placed in the red-blood corpuscles of Cholæpus didactylus; and records the existence in the blood of the elephant of very many nucleated red-blood cells, in all of which, with perhaps one exception, the coloured factor was internally placed, whilst the colourless formed the envelope. Professor Klebs (*Virchow's Archiv*, Vol. XXXVIII. February, p. 190.) describes nucleated red corpuscles from the blood of a child; and A. Böttcher in the same *Archiv*, Vols. XXXVI. p. 424, and XXXIX. p. 42) considers the nature of the colouring matter of the red corpuscles, and the indications of nuclei in them.

EYE.—Max Schultze (*Archiv*, Vol. III. p. 215, 1867) continues his researches into the RODS AND CONES OF THE RETINA. He first

describes the distinctive optical properties of the outer and inner segments of the rods, and points out that they are connected together by a thin layer of a feebly refracting material (Kitt-substanz). The opposite end of each inner segment is either in immediate connection with a nucleated swelling, or, as is the usual arrangement in fish, with a delicate, pale thread, which becomes connected with a granule of the outer granular layer. This thread (Stäbchenfaser) corresponds in its appearance with the pale fibres of the optic nerve. A minute account of the nature of the substance of which the outer and inner segments of the rods in different vertebrata consist, and of the transverse splitting of the outer segments into discs, under the action of various re-agents, is then given. The cones also possess outer and inner segments, the distinctive characters of each of which, and the points of difference between them and the corresponding subdivisions of the rods, are then given. The double or twin cones which Hannover first described he finds not only in fish as H. Müller thought, but in amphibia, reptiles, and birds. In man and mammals the cones are simple. In fish from each half of a double cone a fibre passes into the outer granular layer; but the arrangement in other animals is much more difficult to determine, though he thinks only a single granule corresponds to each double cone. In birds the double cones contain only a yellow pigment, but the simple cones are not only yellow, but orange, deep red, and also colourless. The outer segments of the cones vary considerably in length in birds, but in reptiles they are remarkably short. In only one genus of the many he has examined, viz. Triton, did Schultze find the difference between rods and cones imperfectly marked. Amongst osseous fish he knows only one genus, the eel, without cones. He considers that the inner and outer segments of the rods and cones are essentially different structures, the inner corresponding to the axial cylinder of a nerve fibre, the outer being a peculiar disc-like structure. The longer the outer segment is, the more discs will it contain. Schultze regards these discs as a peculiar reflecting apparatus, and with the increase in the number of the discs the more perfectly is the light reflected. In nocturnal birds the rods have very long outer segments; and in the human retina the cones of the fovea centralis possess the longest outer segments.—Prof. Krause in a preliminary notice (*Göttingen Nachrichten*, Sept. 18th, 1867) thinks it very probable that the optic nerve ends in the retina in a peculiar structure, which may be called the optic ellipsoid. This is an ellipsoidal mass situated in relation to the choroidal extremities of the inner segments of the rods and cones, and connected with a central fibre extending along the axis of these inner segments. This central fibre may be regarded as the terminal fibre of the optic nerve, and establishes a connection between a granule of the outer granular layer and the ellipsoid of the rods, and between the granule of the cones (Zapfenkorn) and the ellipsoid of the cones. It is not to be confounded with the fibre of Ritter in the outer segments, which is probably an artificial product.—In

Henle's Zeitschrift, Vol. XXIX. p. 238, 1867, C. Hasse furnishes a detailed account of the anatomy of the human retina, but our space will not permit us to give an abstract.—J. Cohnheim (*Virchow's Archiv*, March, 1867, p. 343) gives an account of his observations on the SENSITIVE NERVES OF THE CORNEA.

EAR.—As a part of an elaborate memoir on the STRUCTURE OF THE COCHLEA in birds, Dr Hasse (*Siebold u. Kölliker's Zeitschrift*, Vol. XVII. p. 56, 1867) describes the mode of termination of the nerve fibres, and states that he has seen the fibres extend to the lower hyaline end of the rod-like (Stäbchen) cells of the papilla spiralis. Each rod-like cell becomes a nerve fibre. In the lagena also, although the demonstration was not so perfect as in the spiral papilla, he believes that he has seen the nerve fibres end in the rod-like cells. He lays down the following general law, "that in the cochlea the auditory nerve fibres end in cells, which though they may differ from each other in some minute details yet belong to the same general type." His paper concludes with a comparison between the cochlea of birds and mammals.—Dr M. V. Odenius describes the EPITHELIUM OF THE HUMAN MACULA ACOUSTICA, by which is meant the part of the wall of the sacculus and utriculus to which the branches of the auditory nerve proceed. (*Archiv für Mikros. Anat.* 1867, p. 115.) He recognizes three forms of epithelial cells, closely similar to those described by Max Schultze in the otolith-sacs of fishes: viz.; 1st, cylindrical epithelial cells rounded or pointed below, or even with branched thread-like processes from their deeper ends, or of a somewhat hour-glass form with the nucleus in the lower compartment; 2nd, cells like the basal cells of Schultze, only that the peripheral process instead of being lost between the other elements reaches the free surface; 3rd, spindle-shaped cells similar to the thread cells of Schultze. Short stiff hairs project from the entire free surface of the epithelium, they appear to be the peripheral processes or ends of the spindle-shaped cells. Nerve fibres deprived of their medullary sheaths pass into the epithelium, and Odenius thinks he has traced a connection between the axial cylinder and the epithelium, though he is not sure to which element of the epithelium the fibres pass, but thinks it probable that in man and mammals, as Reich has shown in Petromyzon, M. Schultze in fish, and Hasse in birds, the fibres are connected to the spindle-shaped cells.

BLOOD-VASCULAR GLANDS.—G. W. Callender (*Proc. Roy. Soc.* Lond., June 20, 1867) concludes from his observations on the ANATOMY OF THE THYROID BODY IN MAN: 1st. That the thyroid is developed in connexion with the air tube, and has no relation to the thymus; 2nd. It does not consist of two separate lateral masses, and the isthmus is present from the first as a distinct central portion; 3rd. The pyramid is an outlying part of the body, presenting during fœtal life all possible variations as to shape and size.—A contribution on the STRUCTURE OF THE THYROID GLAND, is made by Dr Pere-

meschko (*Siebold u. Kölliker's Zeitsch.* 17th Vol. p. 279, 1867). The connective tissue is more abundant in man than in other mammalia, and in mammals more than in birds. The vesicles lie in the meshes of the connective tissue. He has failed to recognize a membrana propria surrounding the vesicles, but considers that their cavities are lined with cylindrical epithelial cells, which rest loosely on the surrounding connective tissue, so that the vesicles can be isolated without much difficulty. From the deeper, more pointed ends of the epithelium cells 1 to 10 fine processes project, which seem to consist of fine granular particles, and look varicose: these cells are not unlike those described by Pflüger in the salivary glands, but a connection with the fine nerve fibres, such as Pflüger describes, has not been recognized. The vesicles increase in size as the animal grows older, and the contents change from a finely granular mass with nucleated cells and simple nuclei, such as may be seen in the embryo, to a colloid mass, with perhaps nuclei and fat drops. The increase in number of the vesicles by constriction and division can be easily recognized in the thyroid of the embryo. The blood-vessels are numerous, and the capillaries surround the vesicles. Lymph vessels lie not only under the investing capsule of the gland but extend into its substance, and surround groups of vesicles. Although the gland is usually said to be sparingly provided with nerves, yet he finds, more especially in the calf, numerous pale nerve fibres, some of which surround the vesicles and become lost in the connective tissue. Ganglion cells lie amidst the fibres of many of the larger nerves. Peremeschko has also (*Virchow's Archiv*, March, 1867, p. 329) given an account of the STRUCTURE OF THE PITUITARY BODY. He concludes that it is not a nervous organ, but a gland, and that it is most fitly associated with the blood-vascular glands.

SECRETING GLANDS.—The ARRANGEMENT OF THE MINUTE BILE-DUCTS within the liver continues to attract the attention of anatomists. Prof. Hering (*Schultze's Archiv für Mikros. Anat.* 1867, p. 8) describes his investigations on the livers of coluber natrix, of frogs and rabbits, and comes to the following conclusions: the liver in the vertebrata generally may be regarded as a tubular gland, with the tubes arranged in a net-like manner; but in the mammalia in particular a proper tubular structure cannot be recognized, and all the frequently repeated statements of the tubular structure in the mammalia are founded on erroneous observations. The well-known drawings of Dr Beale, which seem to demonstrate the tubes in the lobules of the pig's liver are believed by Hering to be taken from preparations in which the injection is extravasated out of the bile-ducts and the liver cells displaced. It is erroneous also to state, as has recently been done (see our Report for Nov. 1866, p. 146), that the bile-ducts form distinct capillaries within the lobules, which possess a membrana propria, like the blood capillaries, and with which the liver cells lie in contact only externally. The liver is distinguished from other glands by the relatively large surface of contact between

blood-vessels and gland cells. In the lower vertebrata, each liver cell is in relation to the blood canal by at least one surface, whilst in the mammalia, each cell lies in relation to the capillary system by several surfaces: the number of channels for the passage of the bile, relatively to the number of cells, is in a corresponding degree much greater because each cell has a channel, not on one side merely, but on many sides. These channels can be injected from the bile-duct; and when this is done a network-like arrangement is produced. The liver cells themselves constitute the boundaries of these passages, but whether by a distinct cell-wall or only by a sharply defined cell-substance, Hering will not commit himself to say. The channels communicate with the cavities of the interlobular ramifications of the hepatic duct, and transitional cell forms have been observed, between the epithelial lining of these ducts and those hepatic cells, lying in the periphery of the lobule which bound the intralobular bile passages.—As a part of a general enquiry into the structure of the vertebrate liver, Prof. Eberth (*Virchow's Archiv*, May, 1867, p. 70) discusses the relation of the liver cells to the bile-duct, and describes the existence of a network of intercellular passages within the lobules of the mammalian liver.—The Reporter has also made observations on this subject, and, from the examination of a series of preparations of the rabbit's liver, in which the bile-ducts had been injected immediately after the death of the animal, he believes that the bile passes to the periphery of the lobule in channels, which lie between and have their walls formed by the liver cells, and which communicate with the interlobular branches of the hepatic duct.

Dr Macalister gives an account of the COMPARATIVE ANATOMY AND PHYSIOLOGY OF THE GALL-BLADDER (*Medical Press and Circular*, August 7, 14, 1867). It is constant in bimana, quadrumana, cheiroptera, insectivora, carnivora, marsupialia, monotremata; absent in cetacea; variable in edentata, pachydermata, rodentia, and ruminantia. Its presence is the rule in birds and reptiles, but in the latter its position is liable to considerable variation. It is almost universally present in fish. The sac is required in animals whose intervals of feeding are protracted, and is of little use in those in whom the bile flows continuously from the liver, to aid in the almost constant process of digestion.

Prof. F. E. Schulze of Rostock (*Schultze's Archiv*, 3rd Vol. p. 137, 1867) investigates the EPITHELIAL AND GLAND CELLS in the skin of fish and amphibia, in the intestinal canal of all the vertebrata, and the epithelium of the respiratory mucous membrane of vertebrata possessing lungs; owing to the length of the memoir we limit our report to the consideration of the cells of the alimentary and respiratory tracts. In fish, the epithelial lining of the mouth and inner side of the branchial arches does not differ essentially from the epidermis, for irregular, many-cornered, jagged, and awl-like cells, with goblet or flask shaped cells (Becher-Zellen) intermingled, are formed in it. As in the skin, the last form are filled with mucus, and those next

the surface open by a rounded mouth. In the amphibia the difference between the epidermal and the epithelial cells of the mouth is more marked; jagged and awl-shaped cells do not occur; the free surface is covered by cilia, except on the fungiform papillæ of the tongue. Goblet-shaped cells, however, are very general. In reptiles, ciliated and goblet-shaped cells are abundant, and on the tongue of *emys europœa*, jagged and awl-shaped cells, but no cilia. In birds and mammals laminated pavement epithelial cells, but no goblet cells are found. The epithelium of the esophagus in fish, amphibia, and reptiles consists of simple, ciliated cylinders, with goblet-cells: in birds and mammals of laminated pavement epithelium. The epithelial covering of the gastric mucous membrane in all vertebrata consists of cylindrical cells *which open on the surface*, where, their membrane being deficient, a delicate, faintly-granular, or homogeneous substance protrudes. These cells may be compared therefore with the goblet-shaped cells which possess openings on the surface. The cylindrical cells of the mucous glands of the stomach are also destitute of a wall at their free ends. In his observations on the cylindrical cells which cover the intestinal villi, Schulze discusses the nature of the clear border at the free end, which so many observers have described, and considers that it is directly continuous with the protoplasmic contents of the cells. He has not seen the narrow processes from the deeper ends of the cells passing into the substance of the villus, which Heidenhain has described, though he admits that a threadlike process, often dividing into two or more branches, is not unfrequently met with. He examined carefully those cells scattered amidst the cylindrical epithelium, which Henle described as goblet-shaped, and considers that in their structure and other relations they are similar to the goblet-shaped cells already so frequently referred to, and here as elsewhere secrete a mucous substance, which escapes through the opening at their free ends. He opposes therefore the view advocated by Letzerich (*Virchow's Archiv*, Vol. 37) that these structures are especially concerned in absorption. In the large intestine, cylindrical cells also occur which possess a clear border space, though not so broad and shining as in the small intestine; and with its inner boundary line so faint, that the hyaline terminal portion passes over into the granular cell contents. Goblet-cells similar to those in the small intestine are also found. In the glands of Lieberkühn both cylindrical epithelium and goblet-cells are met with in all the vertebrata. The epithelium of the respiratory canal is usually regarded as consisting altogether of ciliated cylindrical epithelium, but in addition Schulze describes very characteristic goblet-shaped cells, occurring in considerable numbers in amphibia, reptiles, birds, and mammals, including man, between the ciliated cells. Theodor Eimer (*Virchow's Archiv*, Vol. 38, March, p. 428) also holds that the goblet-cells stand in no relation to absorption, and he has once succeeded in isolating from the villi of the frog cylindrical cells with long thread-like processes, which contained minute drops of fat at their deeper extremities, an observation which supports the

statements made some years ago by Heidenhain, as to the channels along which the chyle finds its way into the interior of the villus. C. Arnstein also relates his observations on these goblet-shaped cells in the 39th Vol. of the same *Archiv*, and concludes that they arise out of the cylindrical epithelium cells through alterations in their form, which alterations have an intimate connexion with their secreting function. His conclusions are supported by the observations of H. Oeffinger (*Reichert u. Du Bois Reymond's Archiv*, Heft 3, 1867), and L. C. Erdmann in his *inaugural dissertation*, Dorpat, 1867. He states that the intestinal epithelium sends long thin processes into the tissue of the mucous membrane, and considers that Letzerich has committed an error in supposing that the pear or goblet-shaped cells are specially concerned in absorption. Letzerich, however, communicates additional observations in the same volume, p. 435, and not only describes and figures these cells scattered amongst the cylindrical epithelium of the villus, but as communicating by an anastomosing network of canals with the chyle-vessel in its interior. As additional evidence of the uncertainty which prevails with regard to these structures, the paper of I. Sachs (*Virchow's Archiv*, Vol. 39, p. 493) may be referred to, in which it is stated that the goblet-cells are artificial productions.

Prof. Gruber contributes an elaborate memoir (*Mém. de l'Acad. Imp. de St Pétersb.* August, 1866) on the MAMMARY GLAND IN THE MALE, in which he relates his observations on its position, form, size, weight, and development. He then enters very exhaustively into the literature of those cases in which the male breast has enlarged and formed a secretion in its interior, and describes some cases which have come under his own observation.—A. Weisbach (*Wiener Medizin. Wochenschrift*, 1867) records five cases of ABNORMALLY DEEP POSITION OF THE KIDNEYS occurring three times on the right side (in one of which the left kidney was absent); once where both kidneys were situated on the right side, the lower one being more deeply placed; and once where with a horse-shoe kidney the right half had a deep position.

TEETH.—From observations on young specimens, C. Spence Bate, *Annals of Natural History*, June, 1867) has determined the DENTITION OF THE COMMON MOLE, which he expresses by the following formulæ:

$$\text{Deciduous set. Inc. } \frac{3}{3},\quad \text{C. } \frac{1}{1},\quad \text{P. M. } \frac{4}{4} \times 2 = 32;$$

$$\text{Permanent set. Inc. } \frac{3}{3},\quad \text{C. } \frac{1}{1},\quad \text{P. M. } \frac{4}{4},\quad \text{M. } \frac{3}{3} \times 2 = 44.$$

His observations support the inductive analysis previously made by Prof. Owen. An abstract of the researches of W. H. Flower into the DEVELOPMENT AND SUCCESSION OF THE TEETH IN THE MARSUPIALIA, is given in *Proc. Roy. Soc. London*, 1867. The general conclusion is that marsupial animals present a peculiar condition of dental succession,

uniform throughout the order, and distinct from other mammals, which may be expressed as follows; their teeth do not vertically displace and succeed other teeth, with the exception of a single tooth on each side of the jaw. The tooth in which a vertical succession takes place is always the corresponding or homologous tooth, being the hindermost of the premolar series, which is preceded by a tooth having the characters, more or less strongly expressed, of a true molar.

COCCYGEAL BODY. Since the report in our last number on the so-called COCCYGEAL GLAND was written, Dr W. M. Banks has communicated (*Glasgow Med. Jnl.* May, 1867) additional observations on its structure which confirm generally the statements of Julius Arnold. He considers that the minute bodies found connected to the lower branches of the middle sacral artery are essentially dilatations of those branches, which, when cut across, appear like tubes and sacculi surrounded by concentric layers of muscular fibre, and nearly filled with nucleated cells, the fibres and cells representing in an exaggerated form the usual muscular and epithelial coats of the arteries. He agrees with Arnold, Krause, and Meyer, in regarding it as an arterial appendage belonging to the same class as the caudal hearts of some animals, the axillary hearts of others, and the carotid appendages of man and the batrachia. In addition to the examples of modified arterial arrangements amongst the lower animals referred to by Banks, the Reporter may direct attention to the observations of Prof. Allman on the arteries of the armadillo (*Proc. Brit. Assoc.* 1843, p. 68), in which animal not only the arteries of the posterior extremities, but the epigastric and *caudal* arteries have a tendency to divide so as to give rise to a series of vascular pencils.—Julius Arnold has also recorded in *Virchow's Archiv*, July, 1867, p. 497, observations on the GLOMERULI CAUDALES OF THE MAMMALIA. In the dog, cat, squirrel, rabbit, rat, vascular sacs are regularly to be found in the posterior half of the tail, which in their relation to the middle sacral artery and in their construction essentially correspond to the coccygeal glomeruli of man. In the pig, horse, and ox, the connective tissue which surrounds the posterior part of the middle sacral artery contains a widely distributed *rete mirabile*, which is connected with the artery by very muscular branches. In the otter both vascular sacs and retia mirabilia lie in the very vascular envelope of connective tissue, which surrounds the part of the middle sacral artery lying near the tip of the tail. But in none of the above mammalia were regular glomeruli, or retia mirabilia, found in that part of the middle sacral artery which lies on the first six or eight caudal vertebræ. In comparing the coccygeal body of man with the caudal glomeruli of the mammalia, Arnold thinks the relation to the middle sacral artery is more important than its position in the tail.

OVARY AND OVUM.—Theodor Langhans (*Virchow's Archiv*, April, 1867, p 497) records his observations on the GLANDULAR STRUCTURE OF THE HUMAN OVARY, and concludes that the ova arise in gland follicles, connected together in a net-like manner; that the most advanced

stages of development of the ova are found in the deeper part of the ovary, whilst the youngest ova lie near the surface.—In our May number, Dr W. H. Ransom enquires into the conditions of the protoplasmic movements in the eggs of osseous fishes, and in the *Quart. Jnl. of Microscopic Science*, Jan. 1867, he describes the STRUCTURE AND GROWTH OF THE OVARIAN OVUM IN GASTEROSTEUS LEIURUS. The ova are perfect in fry one month old, and in the earliest recognisable ova germinal vesicles may be seen to contain not only the germinal spots, but a delicate translucent colloid mass, on the surface of which the germinal spots are imbedded, and lie in contact with the inner surface of the vesicular wall. The yelk sac is formed in very young ova, and may be separated in those measuring $\frac{1}{200}''$ in diameter; and in the yelk sacs of eggs not more than $\frac{1}{110}''$ in diameter the finely-dotted structure was recognisable. From observations on the button-shaped processes on the outer surface of the yelk sac and the dots in its substance, he concludes that the dotted yelk sac of osseous fishes grows by interstitial molecular deposit. His examinations were conducted in a weak solution of glycerine; and he points out that the ammoniacal solution of carmine employed by Dr Beale is not to be recommended, as the ammonia dissolves the germinal vesicle and its contents. Dr Beale however in reply, in the July number of the same Journal, states that the carmine fluid, if properly employed, instead of dissolving the germinal vesicle or its contents, precipitates particles, and actually forms things which do not exist in the natural state.

MALFORMATIONS.—Huntemüller relates a case (*Henle's Zeitschrift*, Vol. XXIX. p. 149, 1867) in which in an adult a right cervical rib was connected by a bony union with the 1st thoracic rib: and a second case in which the necks of the 5th and 6th ribs on the right side were united by an abnormal articulation.—H. Beigel (*Virchow's Archiv*, January, 1867, p. 144) describes a case of CRYPTORCHISMUS, in which both testicles were retained in the inguinal regions: the ejaculation of semen was normal, and the fluid contained a very large quantity of normal spermatozoa.—E. Ratjen records the case of a man, æt. 49 (*Virchow's Archiv*, February, 1867, p. 172), in whom the LEFT BRONCHUS AND LUNG WERE DEFECTIVE, the malformation, as he believes, being congenital. About one inch from the bifurcation the left bronchus came to a blind end, from which a band of connective tissue was prolonged to the flat, atelectasic lung, to which the pulmonary artery sent a feeble branch. The right lung was largely developed, and extended into the left side of the thorax. There was no trace of pleuritic inflammation.—Julius Arnold describes (*Virchow's Archiv*, Feb. 1867, p. 145), a human female fœtus in which not only the LOWER JAW AND HYOID BONE WERE COMPLETELY ABSENT, but very great deficiencies existed in various parts of the head, and the viscera were transposed; and Albert Bauer gives (*Reichert u. du Bois Reymond's Archiv*, Heft 2, p. 173, and Heft 3, p. 311, 1867) the ANATOMY OF A DOUBLE MONSTER, possessing two heads, three upper, and three lower limbs.

REPORT ON THE PROGRESS OF PHYSIOLOGY, from 1st March to 1st August[1], 1867. By WILLIAM RUTHERFORD, M.D., ARTHUR GAMGEE, M.D., and THOMAS R. FRASER, M.D., *Edinburgh*.

Physiological Chemistry.

BLOOD.—Preyer (*Centralblatt*, 1867, No. 18) adduces facts which lead him to the belief that hæmoglobin is an acid. If a solution of Hb* be exhausted thoroughly with Pflüger's mercurial pump, and then treated with a 10 per cent. solution of sodic carbonate, a slight evolution of CO_2 occurs. If, however, the mixture of Hb and carbonate of sodium be then frozen *in vacuo*, a strong carbonic acid evolution takes place; the optical characters of O-Hb remain unchanged after this treatment. Hæmoglobin thus appears to have the power of expelling CO_2 from $Na_2\,CO_3$, and forming a compound with the metal. Pflüger (*Centralblatt*, 1867, No. 21) describes observations which lead him to differ from Hoppe-Seyler as to all oxidation going on outside the blood-vessels. In opposition to the statement of H.-S. (*Med. Chem. Untersuchung*, I. 133) he states that when blood is allowed to flow rapidly from an artery into a vessel of considerable capacity filled with mercury and standing over mercury, a sudden darkening of the tint will be noticed to take place, long before the period of coagulation. This darkening is prevented by exposure to a temperature of 0° Cent., but occurs as soon as the temperature is raised. Blood which has undergone the darkening does not resume its very florid appearance when exposed to a low temperature. Although this darkening does not positively prove a subtraction of O, it must, Pflüger believes, be considered as affording strong presumptive evidence of it. Heaton (*Phil. Mag.*, May 1867, page 341) in a purely hypothetical paper argues that it is impossible to conceive that oxidation does not chiefly go on in the blood itself. Nawrocki (*Centralblatt*, 1867, No. 12) draws attention to the fact that sulphide of ammonium, besides reducing Hb, as was shewn by Stokes, when present in considerable quantity, exerts a further action upon it. A band of reduced hæmoglobin, and one situated in the red and coincident with Frauenhofer's line C, makes its appearance. Subsequently these bands disappear and give place to two bands, which might easily be mistaken, on superficial examination, for those of O-Hb; after a period varying from 28 to 48 hours the bands disappear. The same phenomena are noticed when sulphide of ammonium acts upon alkaline solutions of hæmatine.

Preyer (*Centralblatt*, 1867, No. 18) finds that sulphide of potassium acts in a somewhat similar manner to the ammonium com-

[1] We do not confine ourselves *entirely* to papers published within the above dates.

* For the sake of brevity the letters Hb will in this report be used to designate Hæmoglobin. The oxygen, carbonic acid, and nitric oxide compounds being represented respectively by the abbreviations O-Hb, CO-Hb, NO-Hb.

pound, when added to solutions of hæmoglobin. When a little piece of K_2 S is added to a cold aqueous solution of O-Hb, the absorption band of reduced Hb makes its appearance. On heating the solution gently two bands appear, of which one is extraordinarily sharp and black; these bands are the same as those described by Nawrocki. On boiling the blood solution thus acted upon by K_2 S, the two new absorption bands disappear, but again make their appearance when the solution cools. A. Gamgee, in a note on the action of nitric oxide, nitrous acid and nitrites on hæmoglobin (*Proc. R. S. E.* 1866-67, No. 73) points out that when nitrites act upon blood, it assumes a chocolate colour, the bands of O-Hb become exceedingly faint, and an absorption band occupying the same position as that of acid hæmatine is superadded. When treated with ammonia the colour again becomes red, and whilst the band in the red completely disappears, the two absorption bands of O-Hb again become more distinct. A very faint absorption band, occupying the junction of the orange and yellow and just below D, then becomes visible. On now treating such a blood solution with deoxidizing agents, the spectrum of reduced Hb is observed, and the solution when agitated with air presents again, in all their distinctness and beauty, the bands of O-Hb.

Hoppe-Seyler (*Virchow's Arch.* XXXVIII. 435) states that when prussic acid is added to blood it cannot be expelled by mere evaporation, and conjectures that this is due to the formation of a compound with hæmoglobin. Preyer (*Centralblatt*, 1867, No. 17) has independently arrived at the same conclusion as H.-S. He finds that neither prussic acid nor cyanide of potassium exerts any action upon even watery solutions of hæmoglobin. When a solution of O-Hb is treated with a solution of KCN and heated, a broad band like that of reduced Hb appears; the O-bands do not, however, reappear on agitation with air. Sulphide of ammonium added to a solution which has been thus treated causes the broad band to disappear and give place to two bands like those of CO-Hb. On passing O into the reduced solution, the broad band, similar to reduced Hb, again appears. HCN acts in an almost similar manner. Preyer believes that there exist compounds of hæmoglobin with HCN and KCN, which are similarly constituted to those formed by CO, NO, and O with Hb. Koschlakoff and Pofoff (*Centralblatt*, 1867, No. 26) describe the action of phosphuretted hydrogen; 1st, on blood; 2nd, on O-Hb; 3rd, on CO-Hb; 4th, on hæmatin. They have arrived at the following conclusions: 1st, that PH_3 decomposes hæmoglobin and hæmatin; 2nd, that pure PH_3 does so without previously reducing these substances; and therefore, the statement that in poisoning by phosphuretted hydrogen death is due to reduction of the hæmoglobin, is devoid of foundation. Heuzinga (*Centralblatt*, 1867, No. 21) states that hæmoglobin is attacked by ozone, the absorption bands disappearing almost instantaneously without the formation of hæmatin. The colourless solution which results contains leucin, but no urea. Körber (*Diss. Dorpat.* 1866) has, under the di-

rection of Alexander Schmidt, examined the action of standard solutions of caustic soda, and acetic acid on the blood of various organs, and of different animals. It results from his experiments that the stability of the hæmoglobin varies remarkably in different animals, and in varying conditions of health. Thus, 0·5 parts of a ten per cent. solution of caustic soda mixed with 20 parts of the blood of a healthy man caused the disappearance of the Hb-bands in four and a half hours, whilst in the case of the blood of a typhus patient similarly treated, the bands disappeared in 55 minutes. Again, 0·5 parts of soda solution were added to twenty parts of blood of different animals, and it was found that the bands of hæmoglobin disappeared in the case of the ox in from 3 to 10 hours, in that of the horse in 51 minutes, and in that of the sheep in 36 minutes.

Dr T. R. Fraser (*Ed. Med. J.* Aug. 1867) has lately investigated the action of galvanism on blood and albuminous fluids with a special view to determining the mode in which galvano-puncture induces coagulation of the contents of an aneurismal sac. When two platinum needles connected with a six-celled Bunsen battery were immersed in a solution of egg albumen of Sp. Gr. 1055, a dense opaque substance of conical shape and acid reaction formed at the positive electrode, whilst a clear, colourless, alkaline jelly grew around the negative pole; the same phenomena essentially occur when solutions of pure albumen and blood are similarly treated. There is no evidence, according to Fraser, that apart from chemical action the galvanic current exerts any influence on the coagulation of fibrin. He attributes the formation of the coagula at the two poles to the action of the acids derived from the electrolysis of the inorganic constituents of the blood, at the positive pole, and of the bases at the negative pole, as products apparently identical in properties are obtained when albuminous solutions are treated respectively with acids and alkalies.

Chemistry of the Tissues and Organs.—Dr L. Hermann has published a very interesting and suggestive work (*Untersuchungen über den Stoffwechsel der Muskeln* U. S. Berlin, 1867, p. 128) on the character of the gases of muscular tissue, and on the interchanges which go on between muscles, separated from the body, and the different gases, in the several conditions of rest, action, and rigor mortis. A very able critical abstract of this work will be found in the *Laboratory* for Sept. 14, 1867. Amongst the most remarkable results of Dr Hermann's researches we may mention, that the gases of muscle are quite free from oxygen, that the respiratory function of muscles which was supposed to exist by George Liebig, Matteucci, and others, is rendered more than doubtful, but that nevertheless when a muscle is thrown into action, or into a state of rigor, there is evolution of carbonic anhydride, which appears to be derived from a carbonic-anhydride generating substance. F. Holm (*Jl. f. pract. Chem.* T. 150-152) found in the alcoholic extract of 650 grammes of the supra-renal capsules of the ox, inosite, hypoxanthine, and a colouring matter insoluble in alcohol, ether, and chloroform, which

the author thinks is probably identical with the pigment of bronzed skin. The author believes that this colouring matter does not exist preformed in the capsules, but is due to the oxidation of a colourless chromogen.

Radziewsky (*Virchow's Arch.* XXXVI. Hft. 1), as a result of his enquiry into the presence of leucin and tyrosin in the healthy body, concludes that leucin is contained in the pancreas, and spleen, the lymphatics, and salivary, thymus, and thyroid glands, and in the liver. It is not found in the testicles, lungs, heart, and voluntary muscles, or in the brain, blood, urine, saliva, and bile. Its presence in the kidneys is doubtful. Tyrosin was never found.

Dybkowsky (*Jl. f. pract. Chem.* 153-164) finds that Neurin, which is one of the products of decomposition of Liebreich's protagon, is, as Bayer had already stated, identical with Strecker's Cholin. Both substances have the formula $C_5 H_{13} NO$, and present the same crystalline form. Neubauer (*Fresenius' Zeitschrift*, VI Jahrgang), announces that when capric or caprylic acids are saturated with ammonia and then brought in contact with water, beautiful myeline forms are produced. Myeline is obviously no chemical principle, but a physical phenomenon, and the generation of the so-called myeline forms may go on altogether independently of the presence of protagon, or, as Beneke thought, of cholesterine. Neubauer separates sarcin and xanthin from muscle by precipitation with nitrate of silver. In the case of sarcin there falls a precipitate having the composition $C_5 H_4 N_4 O + 2Ag_2 O$, in that of xanthin $C_5 H_4 N_4 O_2 + 2Ag_2 O$. Essentially the process consists in dissolving the precipitate in boiling nitric acid, of density 1·1, and crystallizing from this solution. G. Städeler (*Jl. f. pract. Chem.* 148-150) finds that the yolk of egg contains no bile acids, but a substance similar to, and probably identical with, hæmatoidin. S. Moore (*Chem. News*, Sept. 6, 1867) gives the results of the examination of crystals which occurred as a deposit in jars in which brain had been preserved (in spirit?). The crystals were saponified by KHO, and dissolved by hot absolute alcohol. Their melting point was 103°. Elementary analysis gave, as a result, C 43·79, H 8·09, and O 48·12.

SECRETIONS.—Lang (*Wiener Med. Wochenschrift*, 1866, No. 95) in examining the urine of a patient suffering from renal dropsy, obtained reactions which led him to believe that either alloxan, or a substance resembling it very closely, was present. Schültzen (*Zeitschrift Chem. v. Beilstein*, 1867, p. 158; *Laboratory*, I. 278) states that the urine of men or animals poisoned with phosphorus always contains sarcolactic acid; as much as 10 grammes or more is occasionally found in the urine of 24 hours. Prussak (*Centralblatt*, 1867, No. 7) has attempted to discover the cause of the occasional failure of the nitric acid test (Gmelin's reaction) for bile-colouring matter, in jaundiced urine. None of the constituents of the urine have the power of influencing the reaction. It appears, however, that a

febrile condition of the system exerts such an influence on the bile-colouring matter, that it ceases to give its reactions with HNO_5. Tcherinoff (*Moleschott's Untersuch.* x. 232), from a series of experiments made to determine the value of polarizing saccharometers for determining the amount of sugar in diabetic urine, as compared with chemical means, concludes that the latter yield more reliable results.

RESPIRATION.—Pettenkofer and Voit (*Annalen der Chemie und Pharmacie*, CXLI. Heft 3) have undertaken a series of researches in their large respiration apparatus at Münich, with a view to determining to what extent the respiratory functions vary during the day and during the night. Their first experiments were conducted upon a young watchmaker, aged 28 years, and led to a remarkable result, in respect to the difference in the amount of oxygen absorbed and carbonic acid evolved during the day and night periods. The experiments included one day of rest during which the man amused himself by reading and repairing a small clock, and a day of labour in which he was made to turn a wheel heavily charged. The chief conclusions which may be drawn from these experiments are the following: 1st, That in 24 hours the volume of the CO_2 eliminated is about equal to that of the O absorbed; 2nd, That the interchanges of gas effected by respiration go on differently by day and by night, so that the greater part of the O absorption takes place by night and the greater part of the CO_2 elimination by day. Work has scarcely any immediate influence on the oxygen absorbed during the day, although it has a great immediate influence in the amount of CO_2 eliminated. This seems to be formed at the expense of oxygen which has been stored up. 3d. The excretion of urea is not increased by work, although this be long sustained. 4th. The elimination of water is very much increased by work, and the increase continues during the ensuing hours of sleep. Pettenkofer and Voit have, we believe, since repeated these experiments on the man who was the subject of the above experiments, but without confirming the results as to the difference between the day and night periods. (*Centralblatt*, 1867, No 31.)

ORIGIN OF MUSCULAR FORCE.—Parkes (*Proc. R. S.* 1867, No. 94) describes a series of experiments 'on the elimination of nitrogen during rest and exercise on a regulated diet of nitrogen.' These experiments were conducted upon two soldiers at Netley. The experiments were conducted in the same manner as those recorded in Parkes' first paper (see *Proc. R. S.*, No. 89). During four days the men were at their ordinary employment; during two days rested; returned to ordinary work for four days; took very active exercise for two days; and were then for four days more on ordinary occupation. They every day took a diet containing 19·61 grammes of nitrogen. From both sets of experiments which Prof. Parkes has performed, it appears that actually the amount of nitrogen excreted during active exercise, is lower than that excreted during a period of rest, although in the period of rest following work the nitrogen is slightly increased. Pettenkofer and Voit, in their recent paper noticed that work seems

to have no influence on the amount of urea excreted, and that indeed the amount was slightly less on the day of labour than on the day of rest. Parkes suggests the following theory of muscular action. "When a voluntary muscle is brought into action by the influence of the will it appropriates nitrogen and grows; the stimulus or the act of union gives rise to changes in the non-nitrogenous substances surrounding the ultimate elements of the muscular substance which cause the conversion of heat into motion. The contraction continues (the will still acting) until the effete products of these changes arrest it; a state of rest ensues, during which time the effete products are removed, the muscle loses nitrogen, and can again be called into action by its stimulus." Voit (*Zeitschrift f. Biol.* II. 307-365; *Centralblatt*, 1867, No. 7) has studied the urea excretion during starvation. He considers the amount of urea excreted to be a measure of the decomposition of albumen. He finds that at the commencement of starvation the urea excretion goes on much more rapidly than at a later stage, and that the amount of urea excreted at the commencement is in direct proportion to the good state of nutrition of the animal. This first great urea excretion he considers to be derived from an albuminoid substance, which is more easily broken up than the stock albumen upon which the animal subsists for some time longer.

Physiological Actions of Medicinal and Poisonous Substances.

Bromide of Potassium.—M. J. V. Laborde (*Comptes Rendus*, July 8) describes the general results of numerous experiments with Bromide of Potassium on man and on various animals, but principally on batrachians (Rana viridis). Four or five minutes after administering from three to six grains to frogs, a slight general excitation, with somewhat tetanic movements, was caused. This was soon succeeded by weakness and then by a condition of flaccidity, during which reflex action was entirely abolished; but the power of voluntary movement was retained until long after this. The heart was but slightly and gradually affected, and continued to contract for several hours after the loss of reflex power. Laborde concludes that Bromide of Potassium has no special action on the heart, muscles, encephalon, nor nerves; but that it mainly and primarily influences the spinal cord. He also studied comparatively the effects of Iodide of Potassium and Bromide of Sodium—substances whose chemical constitution might suggest a correspondence with Bromide of Potassium in physiological action. Twice or thrice as large a dose of Bromide of Sodium, however, produced no effect; and Iodide of Potassium, though active, differed greatly in the nature of the symptoms it caused. The exhibition of these substances was effected by placing them, in a state of fine division, on the interdigital membrane; and absorption by this surface was found to be rapid. Eulenburg and Guttmann have also examined the physiological action of this substance (*Centralblatt*, 18 May). From thirty to sixty grains given to rabbits by the stomach or by hypodermic injection, caused death in

from ten to forty minutes. A smaller, non-poisonous dose produced paralysis and cardiac irregularity. When one or two grains were injected into the subcutaneous tissue of frogs, paralysis ensued in from ten to fifteen minutes, and it was supposed that this was due to an action on the cord. Neither in these experiments nor in those of Laborde is there, however, any conclusive demonstration given of a spinal action. Eulenburg and Guttmann attribute these effects to the potassium and not to the bromine; for similar symptoms were produced by other salts of potassium, while bromine itself and bromide of sodium and of ammonium were not found to have actions resembling that of Bromide of Potassium.

SULPHOCYANATE OF POTASSIUM.—MM. Dubrueil et Legros (*Comptes Rendus*, 17 Juin) imagined, from the results published by Claude Bernard, Ollivier and Bergeron, that this substance should prove a perfect counteragent to strychnia. These expectations were not fulfilled; for in addition to ideo-muscular paralysis a previous stimulating action on the central nerve-ganglia, and one hitherto overlooked, was discovered. As this produced tetanus, sulphocyanate of potassium is useless in strychnia poisoning. They further contradict the assertion of MM. Ollivier and Bergeron, that a modification is caused in the structure of muscular fibre.

PHOSPHORUS.—The first portion of Dr Dybkowsky's important research (*Chem. Untersuch. von Hoppe-Seyler*, 1866, p. 49) is occupied with a historical account of the theories of phosphorus-action. He discards the opinions of its conversion into the various phosphorus acids, and also the most usual one of its absorption and action in the free state. He concludes that it is converted in the organism into phosphuretted hydrogen (PH_3), and that it acts as such. When PH_3 is administered, the symptoms are the same as those of phosphorus itself; and when phosphorus is placed in a mixture of aërated water, gastric juice and blood, PH_3 is formed. Phosphuretted hydrogen acts by removing oxygen from the blood. Dybkowsky minutely describes the symptoms caused by PH_3, but he unfortunately neglects to mention the pathological appearances; which is remarkable, as those of phosphorus are so well ascertained.

The presence of sarcolactic acid in the urine of man and of the lower animals during phosphorus-poisoning is vouched for by M. O. Schültzen (*Zeitschr. für Chem.* 1867, p. 138). It appears when the symptoms arrive at the stage of yellow discoloration of the skin, and when the urine contains albumen and bile-pigments.

CARBONIC ACID AND OXYGEN.—M. E. Cyon, one of the latest and most successful of the investigators of the nerve connections of the heart, has examined the influences of carbonic acid and oxygen on the cardiac action (*Comptes Rendus*, 20 May). He believes that the former stimulates the regulating centres and thereby increases the blood-tension and the resistance to propulsion, a diminished rate of action resulting; and that the latter stimulates the motor ganglia in

the heart's substance, and thereby increases the frequency of its contractions.

Chloroform, Sulphuric Ether, Amylene, Carbonic Acid and Carbonic Oxide.—Bernstein (*Moleschott's Untersuch.* x. p. 280) concludes that the effects of chloroform are not due to an action on the blood-corpuscles, as Hermann asserted (*Journal of Anatomy and Physiology*, 1867, p. 155), but to a primary action on the spinal cord. He also infers from his experiments that chloroform produces anæsthesia by acting on the sensory nerve cells, and not on the nerve fibres. Important researches on the actions of Chloroform, Sulphuric Ether and Amylene have been undertaken by Professor Ranke of Munich (*Centralblatt*, No. 14, 1867). He believes that in large doses these substances paralyse the terminations of the motor nerves, and that the early appearance of *rigor mortis* is due to their action on myosine (muscle fibrin). Rigor occurs more rapidly after death from chloroform than from either of the two other anæsthetics, and the same order is observed in the rapidity with which a solution of myosine becomes clouded when exposed to the vapours of these substances. They also coagulate solutions of nerve albumen. From experiments with lower animals, Bernstein concludes that Sulphuric Ether is a less dangerous anæsthetic than chloroform. One of the most remarkable of the investigations on chloroform is that published by Dr Faure (Comparative Researches on the Effects of Chloroform and Carbonic Acid, *Archives Gén. de Méd.*, May, 1867, p. 557). Its object is to examine the method in which chloroform and other substances produce anæsthesia; and the general result is that the effects of the inhalation of carbonic acid and chloroform are essentially those of impairment of respiration. Chloroform is said to modify the portions of the pulmonary surface with which it is brought into contact in such a way as to render them impermeable to the air, in virtue of its power of coagulating albumen, and hence to interfere with respiration; and the anæsthesia it causes is asserted to be merely one of the early symptoms of asphyxia. Among other ingenious experiments, the following is given in support of this view. A caoutchouc tube, having one end attached to a vessel containing chloroform, was passed down the trachea, *beyond its bifurcation, into one of the bronchi*, and a large quantity of chloroform was so inhaled by an animal; but no anæsthesia was caused. The tube was then so far withdrawn that *it did not extend to the bifurcation;* and after a very few inhalations complete anæsthesia ensued. During this condition it was again advanced *beyond the bifurcation into a bronchus;* and although chloroform continued to be inhaled the anæsthetic condition gradually disappeared. Thus, if one lung or a portion of one lung is only acted upon by chloroform, no anæsthesia is produced; if both lungs are acted upon, anæsthesia supervenes; and if, during this anæsthesia, one lung is removed from the direct influence of chloroform, the anæsthesia ceases, notwithstanding the continuance of chloroform inhalation by the other lung. Carbonic acid was found to act in the same way.

When carbonic oxide, however, was brought into contact with only limited portions of the pulmonary surface, its characteristic effects were nevertheless quickly produced. It thus appears, according to Dr Faure, that chloroform resembles carbonic acid in acting only by interfering with respiration, and not as a systemic poison; carbonic oxide, on the other hand, passes through the lungs without producing any changes of such a nature as to interfere with respiration, and its symptoms are caused whenever it is absorbed into the system. Many of the experiments in Dr Faure's paper are worthy of repetition by independent observers, and his conclusions are certainly of such importance as to require and deserve confirmation.

M. P. Bert has examined whether a stage of excitement occurs during the action of chloroform and ether, in the sense of a true stimulation of the cerebro-spinal nervous system preceding the stage of depression (*Archives Gén. de Méd.*, May, 1867). This he denies, because, among other reasons, if the spinal cord be divided before the inhalation no symptoms of excitement occurred below the incision, but yet reflex power became abolished there; while above the incision the usual movements occurred. These movements, which constitute the symptoms of the stage of excitement, M. Bert refers to irritation of the mucous membranes by chloroform vapour.

Sulphate of Quinia.—Eulenburg (*Comptes Rendus*, 4 Mars, 1867), concludes, from an extensive series of experiments on frogs, that sulphate of quinia acts energetically as a paralyser of the respiratory movements and of the heart. The former cease from ten to sixteen minutes after the administration of doses varying from half a grain to two grains. The effect on the heart is independent of, and occurred several hours after, the stoppage of respiration. It is supposed to be due to an action on the cardiac muscle itself and on its excito-motor ganglia; as previous division of the vagi did not prevent it. Among other phenomena, it was found that this substance destroys the function of the spinal reflex centre, and afterwards, those of the centres of sensation and of voluntary movement in the cerebrum. Some doubt is cast on this research by a subsequent one of M. Jolyet (*Comptes Rendus*, 2 Avril). This investigator found that when sulphate of quinia was injected under the skin of the feet the effects were quite different from those of its injection under the skin of the back. The latter method was adopted by Eulenburg; and Jolyet asserts that Eulenburg's principal results were, therefore, caused by the direct action on the heart that such administration admits of, and that many of the subsequent phenomena and their sequence were caused by the natural extension, by imbibition, of the substance injected.

Calabar Bean.—Westermann (*Inaugural Dissertation*, Dorpat, 1867, p. 37) and Vintochgau (Action of Physostigmin on Amphibia, *Wiener Acad. Sitzungbericht.* Cl. 2. Abtheil LV. p. 49) confirm many of the facts previously ascertained by Fraser (*Jour. of Anat. and Physiology*, No. II. 1867, and *Trans. Roy. Soc. Ed.* XXIV. part III. pp.

715—787), but add to them nothing of importance. Dr Eben. Watson (*Ed. Med. Jour.* May, 1867) contributes an interesting paper on the same subject, in which some attention is paid to the antagonism of Calabar Bean to tetanus and to strychnia-poisoning.

CURARE.—Dr Hermann (*Reichert und Du Bois Reymond's Archiv*, 1867, p. 64) has explained by a simple experiment why a dose of curare sufficient to kill if introduced under the skin of a rabbit, proves harmless when injected into the stomach. He tied the renal vessels previous to the administration by the stomach, and found that death resulted just as certainly, though not so rapidly, as when the poison was introduced subcutaneously. He believes from this that the immunity by stomach-administration is not due to non-absorption by the mucous membrane of the alimentary canal, but to such tardy absorption as allows of its removal by the kidneys before any poisonous accumulation in the blood. In like manner he accounts for the non-fatal effects of the poison of serpents, and also of various potassium salts, when introduced by the stomach. He explains the fact of even moderate doses of curare poisoning birds when given by the stomach, by supposing that the removal of the poison must be very slowly accomplished as the urine of birds is semifluid. He points out the importance of attending to the state of the excretory organs during the administration of poisonous substances; for if the normal balance between absorption and excretion be disturbed, results may follow that were neither anticipated nor desired.

AKAZGA.—Dr T. R. Fraser describes the chemical and physiological properties of a new West African ordeal-poison called Akazga (*Brit. and For. Med. Ch. Rev.* July, 1867; and *Proc. Roy. Soc. Ed.* 1867). The source from whence it is derived is an unknown strychnaceous plant; and the general physiological properties of the poison are those of strychnia. A new alkaloid has been separated from it by Fraser, which likewise bears a close resemblance to strychnia. We have now, therefore, four alkaloids derived from the genus Strychnos: strychnia, akazgia, brucia and igasuria. They all possess similar physiological properties, but they may be divided on account of their chemical relations into two groups; the one containing strychnia and akazgia, and the other brucia and igasuria.

ATROPIA.—Dr W. Ogle contributes an interesting paper on the comparative immunity of rabbits to the poisonous action of atropia (*Med. Times and Gaz.* May 4, 1867). His conclusions are the following:—1. That a rabbit of middle age can live for, at any rate, six days on belladonna without inconvenience. 2. That enormous doses of atropia may be tolerated, whether given by the stomach or by subcutaneous injection; and that this tolerance is not due to non-absorption. 3. That the tolerance increases with the age of the animal. 4. That old and young rabbits are equally subject to dilatation of the pupils. Ogle refers to some experiments by Dr Camus in which the minimum fatal dose for rabbits was found to be 15·5 grains.

No explanation is, however, advanced of this immunity; and we must yet submit to the mortification of having thus suggested to us our ignorance of the essential causes of the physiological action of poisons, which such curious exceptions prominently display.

The Poison of the Cobra-di-Capella.—Professor Halford of Melbourne has made some experiments with this poison (*Brit. Med. Jour.* July 20, 1867). He says that it consists of molecules of living germinal matter, which, after the inoculation of an animal by the cobra's bite, multiply so rapidly in the blood, that millions of molecules are produced in a few hours, at the expense "of the oxygen absorbed into the blood during inspiration." Hence asphyxia is produced, according to Dr Halford. We imagine that such a theory requires an examination of the gases of the blood after the poisoning.

Salamander Poison.—Dr Zalesky (*Med. Chem. Untersuchungen von Hoppe-Seyler*, 1866, p. 85) has separated an alkaloidal active principle from the poisonous secretion of the salamandra maculata. This he names Salamandrine, and he assigns to it the formula $C_{34}H_{60}N_2O_5$. "In its action on animals, salamandrine has apparently a close resemblance to strychnia; but the spasms produced by the former are clonic, whereas by the latter they are tonic."

Action of Antiseptic Agents on Infusoria. Dr Binz of Bonn (*Centralblatt*, No. 20, 1867) has investigated the effects of various antiseptics upon the animalcules found in vegetable infusions. He particularly examined the actions of these agents upon the Paramecium Colpoda, so commonly found in putrid infusions of hay. The infusion and the antiseptic were allowed to come into contact with each other on a glass slide, while he observed the result by means of a low magnifying power. Binz classifies the substances that injured the Paramecium into two groups:—1. Those that kill by producing osmosis; among which are chloride and hyposulphite of sodium, chlorate of potassium and alum. 2. Those that have a directly poisonous influence: among which are nitric, sulphuric, tannic and acetic acids; creasote, permanganate of potassium, corrosive sublimate, iodine, bromine, chlorine, and quinia. Of the acids, acetic is the most powerful poison. Solutions of 1 part of corrosive sublimate in 1500 of water, of 1 of iodine in 5000 of water, of 1 of bromine in 12000 of water, of 1 of chlorine in 25000 of water were poisonous. Quinia has also a powerful action on the Paramecium; 1 part in 400 of water produces instant death and 1 in 10000 kills in two hours. Strange to say, salacine does not injure this animalcule, even when employed in a solution of 5 per cent.; and a 1 per cent. solution of nitrate of strychnia produced no injury within two hours.

Innervation.

Brain.—Herzen (*Beale's Archiv*, 1867), denies the accuracy of Setschenow's view that there are in certain parts of the brain centres

which inhibit or restrain spinal reflex action: Setschenow found that when certain parts of the brain were irritated, spinal reflex action could be less easily called forth, but Herzen says that this result follows irritation of any considerable portion of the nervous system central or peripheral. Again, Setschenow found that removal of certain portions of the brain was followed by an increase in the facility with which reflex action could be induced; but according to Herzen, removal of any considerable portion of the central or peripheral nervous system produces a great increase in the reflex action in all the other parts of it. Herzen arrives at these results from thirty-five experiments made under Schiff's guidance.

SPINAL CORD.—*Effect of a Constant Electrical Current.* Dr J. Ranke (*Zeitsch. für Biologie*, II. 398) confirms the interesting observation made by Nobili, that the convulsions of an animal will cease if a strong constant current be passed through the spinal cord. Ranke found that no reflex action could be induced in a frog when a strong constant current was passed through its cord. Though a strong current allayed the tetanus produced by strychnia, it did not prevent the death of the animal. A weak current increased the tetanus, a very strong current produced permanent paralysis if continued for some time, while a current of medium strength allayed the spasms and did not produce permanent palsy of the cord. It made no difference in the results whether the current was passed up or down the cord.

CILIOSPINAL CENTRE.—Dr E. Salkowski of Königsberg (*Henle und Pfeufer's Zeitsch.* 3te Reihe, XXIX. 167) concludes that in rabbits the nerves which supply the vessels of the ears and the dilator pupillæ take their origin above the atlas—probably from the medulla oblongata, and not, as Budge supposed, from that portion of the spinal cord opposite the 6th and 7th cervical vertebræ. The nerves traverse the spinal cord without decussation, and leave it by the anterior roots of the 7th and 8th cervical, and 1st and 2nd dorsal nerves, and then pass into the cervical sympathetic.

SENSIBILITY OF THE SPINAL CORD.—H. Engelken (*Reichert's Archiv*, 1867, p. 189) has, under the direction of Prof. Fick, performed several experiments on the spinal cord of rabbits, which have convinced both these observers that the anterior and posterior columns are just as capable of being irritated by electricity as ordinary nerve-trunks are. This view is directly opposed to that advanced by Van Deen, Schiff and Guttmann. The negative results which followed irritation of the anterior columns in the hands of these gentlemen are ascribed by Engelken to their having used mechanical irritants, or too feeble electrical currents. He says that further research is necessary ere anything definite can be said regarding the grey substance.

ARTIFICIAL DIABETES.—Eckhard (*Beiträge zur Anatomie und Physiologie*, 4ter Band, 1tes Heft, 1867) has very decidedly advanced

our knowledge of the parts of the nervous system concerned in the production of diabetes when the floor of the fourth ventricle is punctured. It is well known that diabetes follows the puncture even although the vagi and cervical sympathetics have been previously divided; these therefore do not form the efferent channel through which the puncture perverts the action of the liver. On the other hand, Eckhard found that he could never produce diabetes by puncturing the floor of the 4th ventricle after previous division of the splanchnic nerves. So that it is through these nerves that the influence passes from the medulla oblongata. Simple section of the splanchnics was in one case followed by diabetes, but never again, though the experiment was repeated more than a hundred times. As the splanchnics have been shown to be the most important vasomotor nerves in the whole body, the negative results of these experiments are sufficient to show that Schiff is wrong in supposing that diabetes may be due to dilatation of the hepatic vessels. Irritation of the distal portions of the divided splanchnics was *not followed by diabetes;* so that some apparatus must intervene between the floor of the 4th ventricle and the splanchnic trunks, which required to be irritated ere the diabetes could be established. Proceeding by the method of exclusion Eckhard irritated such of the vertebral chain of sympathetic ganglia as lie within reach. Strange to say he found that section of the inferior cervical ganglion was always followed by marked diabetes. Section of the two first thoracic ganglia was followed by the same result, though it was less marked. Section of the roots of the last cervical and first dorsal nerve was in some cases followed by diabetes; in others the result was negative: the result was always negative when the posterior roots only of these nerves were divided. He has not yet satisfied himself of the results of irritating the divided nerve-roots. The research is not yet complete, but he thinks it is probably the inferior cervical and upper two thoracic ganglia which form the nervous apparatus specially acted upon by the puncture of the 4th ventricle in giving rise to diabetes; at any rate, the research up to its present point, shows that some parts of the central nervous system must be irritated before artificial diabetes can be produced.

Electrotonus.—The following are some of the conclusions given by Matteucci (*Comptes Rendus*, No. 22 and 29, 1867), at the close of a long article "On the Secondary Electromotor Power of Nerves, and its application to Electro-physiology." Electrotonus and secondary polarity are phenomena of the same nature. The increased nerve excitability and the tetanus produced in a limb on the opening of a constant current depend probably on secondary currents which traverse the nerve, and also on the influence exerted on the nerve and muscle by the electrolytic products developed at the ultimate nerve ramifications. According to Fick (*Vierteljahrsch. d. Zuricher. Naturf. Ges.* XI. *Centralblatt*, No. 9, 1867), irritation of a nerve by an inducted current takes place only at the negative pole, and not throughout

the whole space between the poles, as Pflüger supposed. This, however, is only asserted of the inducted current produced on the closure of the current in the primary coil—the opening inducted current is of too short duration to permit of its investigation in this respect. "Researches on the Nature of the Electrotonic State, and the Negative Variation of the Nerve Current," by J. Bernstein (*Reichert's Archiv*, p. 596, 1866), must be perused at length to be intelligible.

Rate of Nervous Conduction.—Helmholtz and Baxt (*Berliner Acad. Monatsbericht*, p. 228, 1867) estimate the average rate of conduction in human motor-nerves at 111 feet per second. This result agrees very closely with that previously obtained by Hirsch.

Another Nerve which dilates the Vessels.—Cyon and Ludwig (*Sächs. Acad. Bericht.* 1866, p. 307—*Jl. de l'Anat.* No. 5, 1867) have found in rabbits that when a branch of the vagus which arises by two heads, one from the vagus near the origin of the superior laryngeal nerve, and the other from the latter nerve itself, is divided and its central end irritated, a remarkable lowering of the pressure of the blood ensues; hence they give to the nerve the title of "Depressor." This branch courses down the neck in close proximity to the sympathetic, and on entering the thorax joins a branch of the Inferior Cervical Ganglion: the combined nerve has been traced by them as far as the dense tissue between the origin of the Aorta and Pulmonary Artery. The pressure of the blood was lowered to a half, and sometimes even to a fourth of the normal mean pressure, by irritating the central end of the divided nerve for some time by means of inducted currents. The result of irritating the peripheral end of the nerve was negative. Slowing of the heart's speed accompanied lowering of the blood-tension: the former was evidently a reflex effect through the vagi, for when the vagi were divided below their union with the "Depressores," and the latter then irritated, no change in the heart's speed resulted, although the blood-tension was lowered just as much as when the vagi remained undivided. Were Marey's theory as to the relation between the pressure of the blood and the heart's speed correct, the heart's speed ought to have been greatly quickened when the blood-tension was lowered, and especially so when the heart was no longer restrained by the vagus. Moreover, they found that the force of the cardiac pulsations was unaffected by irritation of the "Depressor." So that as the lowering of the blood-pressure was not due to any change in the force or rapidity of the heart, they concluded that it was produced by dilatation of the vessels: they suppose that the nerve acts reflexly, and that it inhibits or restrains the action of the vasomotor nerves, thereby diminishing the tonic contraction of the vessels; in short, that this nerve is a great *dilator* of the vessels. They think that it is chiefly the abdominal vessels which are dilated. They conclude that by means of this nerve the heart can lessen the resistance offered to its contraction; perhaps it only acts when the heart is overloaded with blood—for section of the nerve in ordinary cases does not increase the blood-pressure, which

it would do were the nerve in a state of tonic irritation. Their conclusions regarding the function of this branch of the vagus are deduced from a large number of experiments.

CARDIAC MOTOR NERVES.—(Von Bezold, *Verhand. der physic. med. Gesell.* Würzburg, v. 26, Jan. 1867; Bever and von Bezold, *Centralblatt*, No. 23, 1867; E. and M. Cyon, *Comptes Rendus*, LXIV.). Von Bezold and Bever found that irritation of the root of the inferior cervical ganglion (ganglion stellatum) which runs for some distance with the vertebral artery accelerated the heart's speed. According to the brothers Cyon, the 1st and 2nd branches of the inferior cervical ganglion connect the ganglion with the "depressor" nerve (see the notice of Cyon and Ludwig's researches on this nerve): the 3rd branch, that running along the vertebral artery, is the only branch which when irritated quickens the heart. Irritation of the 4th and 5th branches which surround the subclavian artery produces increased blood-pressure. The above is the arrangement in rabbits. In dogs the 2nd corresponds to the 3rd branch in rabbits. The heart also receives motor nerves from the upper thoracic ganglion. These motor nerves of the heart do not appear to be always in a state of irritation, for their section does not influence the heart's speed.

A CARDIAC INHIBITORY NERVE IN THE CRUSTACEA.—Eckhard (*Beiträge*, 1867) finds that the crustacean heart is supplied by a nerve having the same function as the cardiac branches of the vagus in the vertebrata. This paper contains many other interesting facts regarding the effect of temperature and inducted electrical currents upon the heart of Cancer Pagurus.

OPHTHALMIC INFLAMMATION AFTER DIVISION OF 5th NERVE.—Since Snellen and Büttner's researches we have generally believed that the ophthalmic inflammation which follows division of the 5th nerve is owing to the eye having lost its sensibility, and being therefore no longer able to protect itself against external irritants; for when means were taken to prevent the entrance of foreign bodies into the eye, the inflammation did not result. Meissner (*Henle und Pfeufer's Zeitschrift*, 3te Reihe, XXIX. Heft 1, p. 96) has observed that in a rabbit in which he partially divided the ophthalmic branch of the 5th nerve the usual inflammation of the eye resulted, notwithstanding the apparently complete preservation of the sensibility. He is therefore disposed to think that the cut had injured the vasomotor nerves, or more probably the trophic nerves (that is, the nerves which immediately preside over the nutrition of the textures) of the eye. In the succeeding number of the same journal (p. 217), Schiff writes to say, that Meissner's observation entirely supports the explanation of the phenomenon advanced by him in his *Nerven Physiologie*, p. 387, and that he has observed four cases in which, after injury to the 5th nerve inside the skull in animals, the ophthalmic disturbance followed, notwithstanding the preservation of the sensibility of the eye and its appendages.

CHANGES IN THE TESTIS RESULTING FROM DIVISION OF THE SPERMATIC NERVE.—I. Obolensky of St Petersburg (*Centralblatt*, No. 32, 1867) has found that after section and removal of a portion of the spermatic nerve in rabbits and dogs, fatty degeneration of the epithelium of the tubuli seminiferi always results—leading to atrophy of the gland. The areolar tissue of the organ often becomes converted into adipose tissue in such cases. These changes result, although the vessels supplying the gland remain intact. Nélaton has observed atrophy of the testicle following section of the spermatic nerve in man.

RELATION OF THE VAGUS TO THE NERVES WHICH SUPPLY THE BLADDER.—Dr F. Kehrer of Giessen (*Henle und Pfeufer's Zeitschrift*, 3te Reihe, XXIX. 144) has from experiments on rabbits and dogs come to the conclusion that Œhl was wrong in saying that contraction of the bladder could be induced by irritating the central end of the divided vagi (*Comptes Rendus*, Aug. 1865). Kehrer's experiments were performed under the direction of Eckhard.

INNERVATION OF THE PAROTID GLAND.—Wittich (*Virchow's Archiv*, XXXIX. p. 184) does not think the influence exerted by the cervical sympathetic on the Parotid secretion so doubtful as Eckhard supposes (see previous No. of *Jl. of Anatomy and Physiology*, p. 361). He always finds that irritation of the cervical sympathetic causes an increased flow of saliva from Stenson's duct, and does not think that this can be attributed simply to pressure from the gland of its contained secretion. He agrees with Eckhard, however, that irritation of the nerve fails in about five minutes or so to excite the secretion; he thinks that this is probably due to exhaustion of the nerve. He considers that the question as to whether or not the parotid secretes constantly is left undecided by both Eckhard's researches and his own.

ON THE DIFFERENCE BETWEEN EXCITABILITY AND CONDUCTABILITY IN THE PERIPHERAL NERVOUS SYSTEM.—Schiff (*Henle und Pfeufer's Zeitschrift*, (3) XXIX. p. 221) says that at a certain stage of poisoning with conia and curare in frogs where a ligature has been placed round all the textures of the thigh except the sciatic nerves, reflex movements can be produced in the ligatured limb, although the nerve cannot be irritated by means of a galvanic current. Schiff therefore thinks that this supports the idea of the non-identity of the *excitability* and *conductability* of a nerve fibre.

Want of space forbids our abstracting papers by Adamük, "On the Influence of the Sympathetic on the intraocular pressure" (*Centralblatt*, No. 28, 1867). Jolyet, "On the nerves which preside over the movements of the Œsophagus" (*Robin's Jour.* p. 308, 1867). Onimus, "On the production of reflex movements by constant and interrupted Galvanic Currents" (*Ibid.* No. IV. 1867).

Miscellanea.

NUTRITION. Dr Lionel Beale (*Quarterly Jl. of Mic. Sc.* July, 1867) enters pretty fully into the question of nutrition from the

microscopic side of the question. He believes that the *serum* of the blood is the nutritive pabulum of the body; that the red corpuscles are concerned in its distribution and in preventing changes in the composition of the great mass of the blood as certain constituents are removed from or poured into it; that the white corpuscles are masses of germinal matter concerned in the formation of the serum as well as of the red corpuscles; and that the special products of nutrition depend not so much on the characters of the pabulum as upon the *converting* powers of the germinal matter throughout the textures and which *appropriates* from the pabulum the materials it requires. The red corpuscles have therefore assigned to them a secondary position as agents of nutrition. The principal argument in support of this is derived from the fact that elaborate tissues are formed in animals which have no coloured blood corpuscles. According to Beale three distinct phenomena are involved in nutrition. 1. The contact of the soluble pabulum with the germinal matter of the tissues. 2. The separation of the elements of the pabulum from their state of combination. 3. The rearrangement of these elements and the conversion of some of them into new germinal matter.

Action of Electricity on white-blood Corpuscles, Pus and Salivary Corpuscles.—Prof. Neumann of Königsberg (*Reichert's Archiv*, p. 31, 1867) continues his observations on the action of inducted currents on blood, &c. (See his first paper on the subject in *Reichert's Archiv*, No. 6, 1865). Under the influence of strong inducted currents the white-blood corpuscles of the frog swell out, their walls become quite smooth, molecules and granules accumulate round the nuclei, while a clear space is left between these and the walls of the corpuscles: the molecules begin to exhibit lively movements and the corpuscles lose all their contractile properties, inasmuch as they do not alter their shape after the withdrawal of the current. Pus-corpuscles are acted on in a precisely similar manner. Brücke observed that the molecular movement in the salivary corpuscle ceases under the action of inducted currents. Neumann, however, observed that white-blood and pus-corpuscles when acted on by water become so like salivary corpuscles that he cannot distinguish the former from the latter;—"there is the same globular form, the same want of contractility, the same lively molecular movement" in the one case as in the other, and electricity then has the same effect on all three. He makes also some observations on the action of inducted currents on spermatozoids and cilia.

Chymograph.—According to Schummer (*Inaug. Diss.* p. 40, 8vo. Dorpat, 1867), Ludwig's Chymograph ("Kymographion") serves perfectly to register the absolute blood-pressure and the frequency of the cardiac contractions, but Fick's chymograph enables one to study the form of the pulse curve with greater accuracy.

Deglutition.—Moura has a paper on the act of deglutition in the *Jl. de l'Anat. et Phys.* Nos. 2 and 3, 1867, which does not however bear satisfactory abstraction.

NOTICES OF RECENT DUTCH AND SCANDINAVIAN CONTRIBUTIONS TO ANATOMICAL AND PHYSIOLOGICAL SCIENCE. By W. D. MOORE, M.D., Dub. et Cantab., M.R.I.A. &c. &c.

1. *Undersögelser angaaende Brug og Nytte af vore stivelseholdige Næringsmidler. Af Professor Dr Faye.* (*Særskilt aftrykt af Vid.-Selskabets Forhandlinger for* 1866). Investigations respecting the use and value of our farinaceous aliments. By Prof. DR FAYE (from Trans. of Acad. of Sciences [Christiania], 1866).

Professor Faye, in a series of experiments with saliva external to the body, and by dietetic experiments upon himself and others, showed that raw starch taken in moderate quantity is completely assimilated by the digestive organs of man. He also proved that the object of the addition of raw meal to the national diet is to render it slower of digestion, whereby the return of the feeling of hunger is deferred, and the languor and debility attendant upon an empty stomach are avoided. These remarks acquire additional interest from their perfect coincidence with observations made by the late Sir Henry Marsh, in a short essay on the "Food of the Labourer," in 1847, during the fearful famine in Ireland in that year. See account of these investigations in *Brit. and For. Med. Ch. Rev.*, July 1867.

2. *Bidrag till örats pathologiska anatomi, af M. V. Odenius, Med. Archiv,* III. No. 4, Stockholm, 1866. A contribution to the path. anat. of the ear. By M. V. Odenius, Swedish Archives of Medicine, III. No. 4.—It describes "a way by which morbid processes may be transmitted from the middle ear to the cavity of the cranium," through a vascular foramen situated without, and above the opening of the internal meatus auditorius, usually described as the opening of a diploic canal, or as destined for the transmission of a small vein. The communication is translated *in extenso* in *Dubl. Quart. Jl. of Med. Science.*

3. *Undersökningar om arterutvidgning såsom följd af nervretning, af Dr C. Lovén. Hygeia, Nov.* 1866, p. 425, Stockholm. Investigations respecting arterial dilatation as a result of nervous irritation. By Dr C. Lovén.—The experiments were performed principally upon animals under the influence of Curare. The phenomena witnessed upon irritation of sensory nerves, are changes in the impulse of the heart, in the diameter of the small arteries, and in the pressure of the blood. The object of his first series was to supplement the researches of von Bezold, which leave it undecided, whether the increase of the pressure of the blood depends upon an elevation of the heart's action, or upon increase of resistance in the course of the circulation. The vessels observed were some small arteries in the ear and hind leg. The vagus was left uninjured. In the leg he selected the saphena artery, which is remarkable for its irritability, the central portion of the divided nervus dorsalis pedis being tetanised. If the

auricular vessel was observed, the central end of the posterior or anterior auricular nerve was irritated. The results showed that the augmentation of the pressure of the blood is due, not to increased action of the heart, but rather to an obstruction to the efflux. Thus it appeared that if the pressure of the blood increased considerably, notwithstanding that the heart's pulsations became slower, the visible small arteries contracted to the disappearance of their bore. If, on the contrary, the pressure of the blood diminished under the irritation, the arteries became dilated.

The diminution in the impulse of the heart observed in irritation of a sensory nerve, is brought about preeminently by reflex irritation of the nervus vagus, the number of the pulsations after the division of this nerve falling either not at all or only inconsiderably. It may even, as von Bezold has shown, under such circumstances rise considerably.

The second section of the paper is devoted to the subject of *arterial dilatation from irritation of the posterior and anterior auricular nerves.* When the central nerve-stump was irritated in a strong, unpoisoned animal, in most cases after the commencement of the irritation the auricular artery was contracted; and this the more certainly and rapidly, the more vehemently the animal manifested pain. The contraction of the artery continued for a time, different in different cases, but always very short, and afterwards gave place, even while the irritation continued, to dilatation. The latter always commenced in the trunk of the auricular artery, and proceeded thence rapidly to smaller and smaller branches. It was not until this had taken place that the veins filled and the ear acquired a deep red colour.

Does the dilatation in this case occur merely in consequence of the previous contraction,—in other words, is it a result of the exhaustion produced in the sympathetic by the previous effort? If this were so, we should expect that a certain proportion should exist, as to duration and intensity, between contraction and dilatation. But this is by no means the case. From another fact also the author infers that it is not at all so easy to exhaust the sympathetic nerves.

The third section treats of *dilatation of the arteria saphena by irritation of the nervus dorsalis pedis.* This artery is in the rabbit particularly well adapted for experiment, as it receives its sympathetic branch from the lumbar plexus and separately from the nervus saphenus. The dependence of the arterial muscles on the nerve mentioned is easily demonstrated, for if we divide the nervus saphenus, the artery of the same name is suddenly dilated, while if we irritate the peripheral stump of the nerve, the vessel contracts.

On irritating the central extremity of the divided nervus dorsalis pedis, an extraordinary dilatation took place in from four to six seconds in the saphena artery, which had previously been only just visible. The dilatation ceased completely in some seconds after the withdrawal of the galvanism. The dilatation was attended with strong pulsation.

In the fourth section Dr Lovén remarks, as an inference from the

foregoing experiments, that irritation of a sensory nerve always gives rise to changes in the pulsation of the heart, which commonly becomes slower, dilatation or contraction of the bores of the arteries being at the same time produced. According to the experience of all investigators it is beyond doubt that the phenomena so exhibited by the muscles of the organs of circulation, are produced in a reflex mode. From the author's observations it would appear that relaxation in the muscular structure of the arteries cannot occur independently of a preceding stronger contraction of the same. Sensory irritation is capable, therefore, by reflex action, both of elevating and depressing the tone of the vascular nerves, and it is impossible, in the present state of our knowledge, to foretell in what cases it shall increase or restrict the contraction. The transition of reflex actions appears to take place in the medulla oblongata.

The fifth section treats of *dilatation of the branches of the arteria profunda penis through the influence of nervi erigentes.* Can the dilatation of the arteries of the penis in consequence of the irritation of a peripheral nerve-trunk be explained in accordance with the principles of the contraction theory? We possess only one mode of deciding this question: the demonstration of a nervous apparatus acting tonically and situated between the dilating nerve and the muscles. From analogy with the heart the author believes himself justified in assuming the existence of such a tonegiving organ, if ganglionic cells are scattered in a nerve shortly before its peripheral termination, as is the case in the dilating nerves discovered by Cl. Bernard in the salivary glands.

Though Eckhard showed, some years ago, that from the sacral plexus two nerves proceed, by the irritation of which the current of blood through the penis is exceedingly promoted, he left us in uncertainty as to the mechanism on which this phenomenon is founded, as he could neither demonstrate the dilatation of the arteries, nor discover any ganglia in the penis. By a close anatomical examination of the penis in the dog, Dr Lovén has succeeded in discovering numerous ganglionic groups along the course of the nervi erigentes. Of the nerves running along the membranous portion, only those found on the lateral and posterior (superior) surfaces belong to the nervi erigentes; irritation of the anterior does not produce erection, nor does their division hinder its occurrence. Both these effects are, on the contrary, produced by a corresponding interference with the nerves first named.

The author has met with ganglia and ganglion-like formations in the following hitherto unknown situations: (1) On the posterior surface of the membranous portion of the urethra; they occur to within some few lines' distance from the posterior boundary of the bulb, but particularly abundantly in the depression between the prostate and the urethra. The ganglionic cells lie either singly or united in groups, in form they are either ordinary ganglionic cells with abundant yellowish granular protoplasm, or are of peculiar formation. (2) In the dense connective tissue in the posterior (superior) part of

the bulb lie ganglionic cells with scanty, very pale, finely granular protoplasm, in larger or smaller groups, or also singly among the nerve-filaments. (3) In the network formed by the lateral bundles of nervi erigentes around the vessel on the side of the bulb, lie peculiar enlargements of the pale nervous fasciculi, which are filled with numerous nuclei, and a very pale finely granular mass.

The author treats next *of the changes in the penis, which accompany the acceleration of the circulation produced by irritating the nerves of erection*, and concludes his paper with some remarks upon erection in the dog.

4. In the *Nederlandsch Archief* or Dutch Archives of Medicine, &c. III. 1e. Aflevering, Drs H. Snellen and H. G. Miller detail a number of experiments performed with a view to solve the question: *can cholera be communicated to the lower animals?* They were made, during the epidemic of 1866 so fierce in Utrecht, on pigs, dogs, monkeys, rabbits, poultry, pigeons, frogs, and fishes. "In 37 instances food mixed with fæces was administered. The fæcal matters were derived from different cholera-patients, quite fresh or in different stages of decomposition. Seven times they administered vomited matters; eight times different parts of the body; once a poultice which had lain on a cholera-patient. Moreover they five times used hypodermically the fæces, vomited matter or blood of a cholera-patient, twice such matters were injected into the jugular vein, once they were given in the form of enema. On one animal the inspiration experiments were fully tried, on all the others they were tried in some degree, all having been exposed for a longer or shorter period in a damp cellar to the exhalations of the matters employed. Similar experiments were performed at Amsterdam by Drs Stokvis and Guye, and in Berlin by Drs P. Guttman and A. Baginsky. A retrospect of all these experiments leads to the conclusion, that to the animals operated on, *cholera is not communicable by infection.*

Are animals then not susceptible of cholera, or is it not by infection, that this disease is transmitted? From the results of their own further investigations, as well as from the experience of the directors of the Zoological Gardens at Rotterdam and Amsterdam, the authors come to the conclusion that animals are not susceptible of cholera. "It is remarkable," they say, "that the statements respecting cholera in animals appear the more positive and convincing, in proportion as they are of older date and come from more distant parts." They show that "before a coexistent epizootic be admitted to be cholera, sound criticism requires: 1, that there be conformity in the morbid process; 2, that anatomico-pathological conformity be established on postmortem examination; and 3, that the outbreak of the epidemic also do not want the marks recognised as peculiar; this last, with respect to the time and place of outbreak, as well as to the nature of the contagion.

"At present 'rinderpest' prevails contemporaneously with 'cholera' as an epizootic. No one for this reason thinks of a connexion

between cholera and rinderpest. If the facts connected with the subject were less known to us, as is the case with communications of earlier date and from more remote localities, the contemporaneous occurrence of the two might probably be received as a strong proof.

"The rinderpest at present prevailing has only this in common with cholera, that the disease is limited to particular animals. Only ruminants are susceptible of it. Man is not attacked by it. The fact is consequently not so anomalous, that cholera cannot be conveyed from man to other animals."

5. At page 105 of the same Journal, Professor Donders describes *two instruments intended to determine the time required for psychical processes.* The first, called the *noematachograph*, serves for determining more or less complex operations of the mind. It consists of a cylinder, in many respects similar to that of the phonautograph, on which the time is registered by a vibrating tuning-fork. The vibrations of the latter indicate 1° the moment when a stimulus acts, and 2° that when the sign of perception, the signal is given.

It was found that the solution of a dilemma, and the corresponding action (turning a wooden bar right or left), requires more time than simple reaction on a stimulus, and that the difference is much more considerable with conventional (exhibition of red or white light, seeing or hearing the vowels *a* or *o* &c.) than with natural signals, while on the former the exercise of practice is rapidly felt. The difference in two experiments, the one with, the other without, solution of a dilemma, represents the time required for the psychical process of distinguishing and of distinctive expression of the will.

The second instrument, the *noëmatachometer*, determines the shortest possible time for a simple idea. By a peculiar arrangement a sound is heard and a spark is seen at a very short interval. The time required to determine the priority, which is varied at the will of the experimenter, is that necessary for a simple idea.

6. Professor Donders likewise contributes to the same Journal (p. 80) a paper on the *cardiograph*, explaining his method of testing the degree of accuracy with which graphical instruments register. The results to be attended to in practice are: 1. That the friction of the pin has very great influence. The less this is, the more accurately are slight alterations of pressure registered; but the greater and more numerous are the accessory vibrations, and the farther does the pin penetrate in sudden impulses. We must therefore modify the friction according to the course of the curve we have to register. 2. When the tension of the membrane is slight, the lever strikes more strongly, and the accessory vibrations are in general greater but less numerous. Slight tension is therefore not available for rapid periods with strong impulses. In slow periods it gives the advantage of greater results, so that slight changes are more accurately recognised. From 1 and 2 it follows that, 3. The tension in general must be greater the greater the friction is, and both must be greater the more violent the impulses are. With great friction slight tension

is quite useless. 4. The pressure of the lever on the vertical plate is the greater, the nearer the point of rest is to the axis.

7. *Some anatomical abnormities, observed in the dissecting-room of the Marine Hospital at Willemsoord.* Under this title Dr D. Hellema gives short descriptions (*Geneeskundig Tijdschrift voor de Zeemagt* 5 Jaargang, and *Ned. Archief voor Genees en Natuurkunde*, III, 1e Aflevering, p. 125) of 1. A separate cleido-mastoid muscle. 2. Two unusual muscles, in place of the ordinary subclavian muscle, at each side, in the same subject. Of these one agreed partially with Luschka's musculus supraclavicularis. It arose from the posterior surface of the sterno-clavicular articulation, ran parallel to the clavicle, and was inserted into the upper margin of the scapula, to the inside of, and close to, the transverse ligament. The other was a subclavian muscle following an abnormal course, which had attached itself to the ligamentum transversum scapulæ. 3. A partial, independent insertion of the soleus muscle, by a tendon into the os calcis. 4. A musculus biceps brachii, with a supplemental head, from the humerus. 5. An origin of the arteria innominata, situated more to the left than usual, the vessel running across and in front of the trachea, to the right. 6. An unusual course of the fifth cervical nerve in front of the musculus scalenus anticus. 7. An abnormal situation of the right suprarenal capsule, the latter lying at the hilum renale, above the renal artery, and not coming in contact with the liver.

8. A double renal pelvis and double ureter on the left side, the two ureters opening, *still separately*, into the bladder on the left side.

PROF. VAN DER HOEVEN in a note to me says, that having for some months had the opportunity of examining Menobranchus, he was fortunate enough to find the blood-discs well formed in the coagulated blood of the bulbus aortæ. They are as large as those of Proteus, perhaps still larger; but what is remarkable they had exactly the form of those of Proteus. In Cryptobranchus they are broader, more like those of the frog. Axolotl, not being a proteid, has no greater blood-discs than other Salamanders or water-newts.

G. M. H.

The society of Arts and Sciences, Utrecht, offers prizes (valuable gold medals) for replies to the following questions :—1. Sur la valeur du Sphygmographe pour le diagnostic. 2. Quels sont les progrès que la connaissance de l'électricité atmosphérique, de ses causes et de

ses lois, a faits pendant les vingt dernières années? 3. Des recherches chimiques et physiologiques sur la digestion des poissons d'eau douce. 4. Des recherches chimiques et physiologiques sur la digestion des reptiles, tant des Dipnoés que des Monopnoés. 5. Des recherches sur le développement d'une ou de plusieurs espèces d'animaux invertébrés dont l'histoire n'est pas encore connue; le tout accompagné des figures nécessaires pour l'intelligence du texte. (Cette question est permanente par sa nature et l'on peut y répondre chaque année). 6. Une description des dents de lait de quelques rongeurs, nommément des *Sciurines*, accompagnée des figures nécessaires. 7. Une série d'observations sur les quantités d'eau, qui s'évaporent de divers terrains et de diverses plantes, dans des circonstances différentes. 8. On demande un examen comparé du tarse chez les diverses familles des mammifères, accompagné de figures explicatives. 9. Quand on observe les phénomènes optiques et calorifiques que présentent les mélanges salins, quelles conséquences peut-on en tirer à l'égard de la loi de BERTHOLLET? On demande de nouvelles observations à ce sujet.

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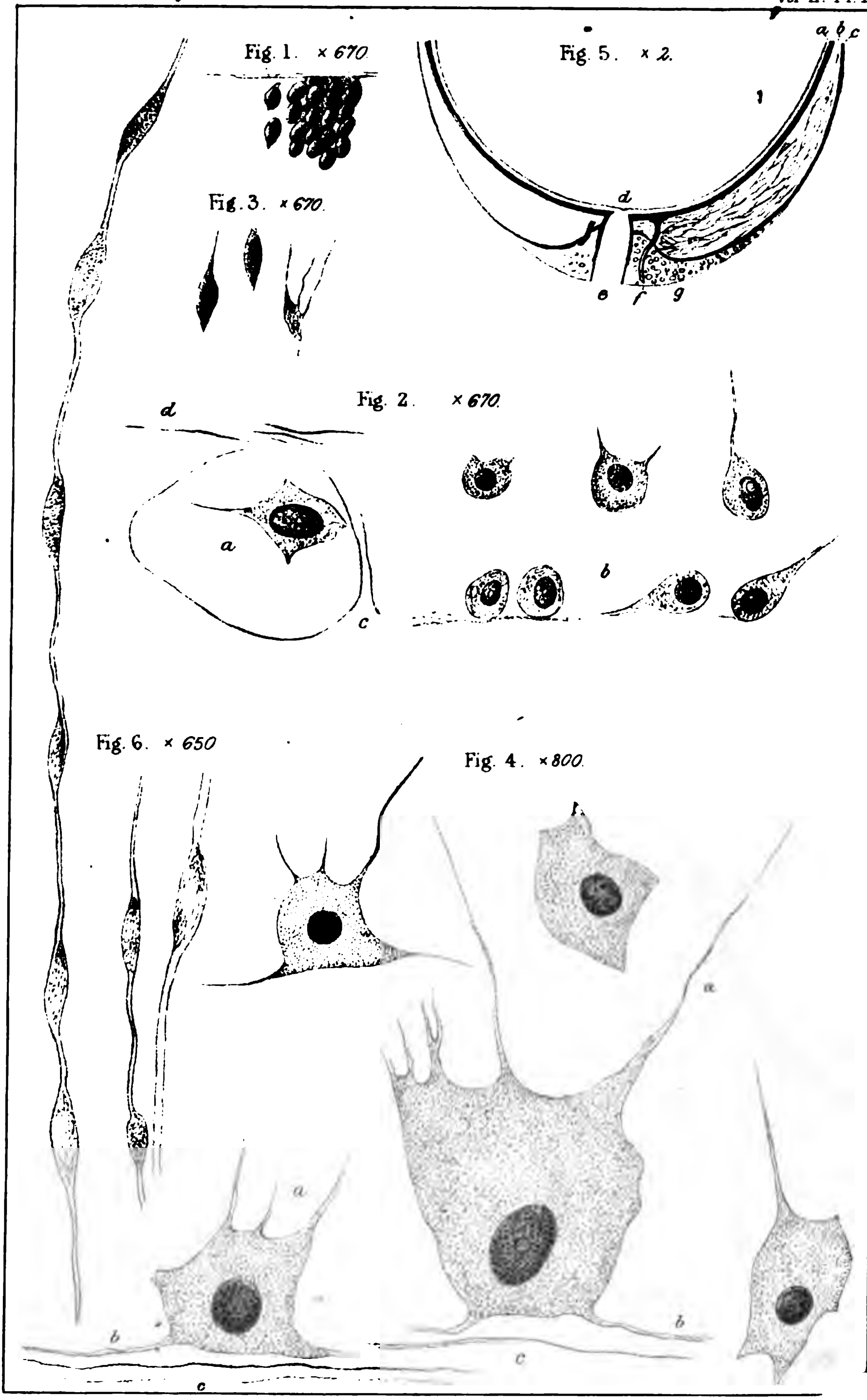

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RETINA OF PORPOISE.

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RICKETY DWARF. *page 42.*

Journal of Anatomy and Physiology.

ON AN ABNORMAL ARRANGEMENT OF THE PERITONEUM, WITH REMARKS ON THE DEVELOPMENT OF THE MESOCOLON. By Professor CLELAND, M.D., *Galway*.

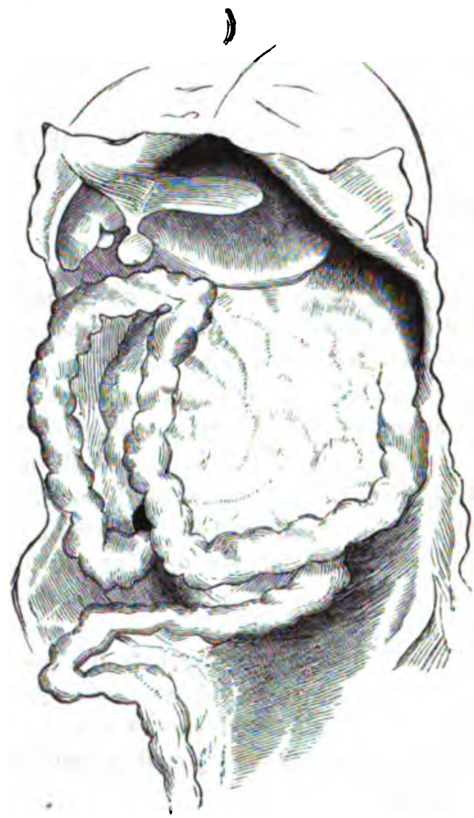
IT is now more than ten years since the abnormality about to be described was observed in the dissecting rooms of the University of Edinburgh, and it would probably have still remained unrecorded, had not the able remarks on the development of the peritoneum made in the last number of this Journal by Dr Chiene in elucidation of an abnormal disposition, in some respects perhaps more interesting than this, led me to refer to a sketch and notes which I had preserved.

The subject was an adult. On opening the abdomen, the peritoneal surfaces were found healthy, and free from inflammatory adhesions; but the entire mass of the small intestines remained concealed from view, being lodged within a secondary sac bounded by omentum and mesocolon, and communicating with the general sac by means of a small aperture at the upper margin of the ileocœcal junction, only large enough to admit the passage of a finger.

The cœcum and ascending colon occupied the usual position. The transverse colon was elongated into an arch which descended alongside of the ascending colon, dipped slightly into the pelvis, and then ascended to the left lumbar region, where it turned sharp round, and was continued into the descending colon, which was concealed from view. The sigmoid flexure

was elongated so as to approach the cœcum; and the rectum lay toward the right side of the pelvis.

The peritoneum in the upper part of the abdomen, including its disposition at the foramen of Winslow, and the connections of the duodenum, was normal. The ascending colon was bound down as usual, but there was a considerable mesocœcum. The fold of peritoneum traced from the anterior sur-



face of the stomach was continued uninterruptedly downwards, in front of the small intestines, to the arch of the transverse colon which it partially invested; it then passed directly onwards to invest in like manner the anterior surface of the elongated sigmoid flexure, and descended to the rectum. This

same fold of peritoneum traced laterally from the concavity of the inverted arch of the colon was seen on the right side to invest the anterior surface of the limb of the arch and pass back to the posterior abdominal wall before extending outwards to the ascending colon; while, on the left side, after investing the limb of the arch, it passed back to the part of the abdominal wall external to the descending colon, which was thus concealed.

On opening into the bag containing the small intestines, which was done by means of incisions extending from the natural inlet, along the convexity of the arch of the transverse colon, the small intestines were seen lying entirely to the left of the middle line, and attached by a mesentery as usual; and the descending colon was seen lying behind the neighbouring portion of the transverse colon, invested with peritoneum. In fact, by making the incisions mentioned, the normal arrangement of peritoneum may be said to have been produced. The sac of the great omentum, however, does not appear to have gone down so far as the transverse colon.

It will be seen from the sketch that the left lobe of the liver was abnormally long and narrow, and that from its anterior border hung an additional lobe about the size of a watch.

The abnormal arrangement of the peritoneum in this case, however startling it may appear at first sight, is, like most things of the sort, susceptible of simple explanation. At a period of development when already the cœcum had passed round into its permanent position, the peritoneum on the concavity of the arch formed by the ascending, transverse, and descending colon had ceased to expand, and remained as the ring of the aperture leading into the abnormal pouch, while the colon continued to grow. The transverse colon, being brought into the position from which it takes its name, by the travelling of the cœcum over the duodenum and then downwards, lay at first in this instance, as in every fœtus, in a direct course across the abdomen, above the mass of the small intestines. But the fold of peritoneum along by the concavity of the arch of the colon ceasing to grow and happening to be bound down at the cœcum, came gradually to occupy in the rest

of its extent a lower and lower position in relation to surrounding parts, as these went on growing; and thus the small intestines no doubt passed gradually through the ring, or rather the ring came gradually down over them at a period when they were sufficiently small to pass in a mass through it. Thus far, I apprehend, there cannot be the smallest doubt as to the mode of origin of this curious abnormality; but the cause of the arrested development of the entrance ring of the adventitious sac remains to be explained. It is unlikely that it was due to a band of subperitoneal thickening, as even if such a band were to take so long, so linear, and so regular a course as to run the whole length of the colon it could scarcely do so without adhering as much to the intestine as to the peritoneal fold. The only explanation therefore which I think can be offered is that after the cœcum had reached its permanent position the great intestine continued to grow at a more rapid rate than the surrounding parts. Up to that period the proportionally great growth of the colon is normal; the further continuance of it therefore would only be an undue duration of a normal action. By such continued elongation of the colon, it may be imagined that the festoon of the transverse colon was formed: and in explanation of the peritoneum passing directly across the necks of the loops formed by the festoon with the ascending and descending colon, respectively, instead of adhering to the concavities of those loops, it may be noted that the circumstance is only in keeping with what occurs normally elsewhere, as for example at the right and left triangular ligaments of the liver.

It is apparent that the arrangement in this abnormality is unfavorable to the view with regard to the arrangement of the mesocolon introduced to the British Schools by Mr Holden and referred to by Dr Chiene. That view, according to which the mesocolon is to be considered as distinct from the great omentum, originating with Haller, has in consequence of the eminent names of those who have at different times made observations in confirmation of it assumed a considerable importance, and it is desirable in order to determine its measure of accuracy that more minute attention should be paid to the development

of the parts. With this object I have carefully examined the only material at my disposal, a couple of fœtuses each rather less than 2½ inches in length.

In these specimens the cœcum had crossed the middle line but had not yet begun to descend. The descending colon occupied a position similar to what it occupies in the adult, but instead of it being fixed down in that position, it was found that together with the left half of the transverse colon it was attached by a broad mesocolon to the abdominal wall in the mesial plane. The foramen of Winslow was situated as in the adult, and when spirit was injected through it, the sac of the omentum was seen to be already pendulous, its walls being arranged in loose folds along the lower margin of the stomach, and the layer continued from the front of the stomach, passing backwards to the abdominal wall immediately below the pancreas. But in the mesial plane the pyloric end of the stomach was connected to the colon by a very narrow fold of peritoneum stretching directly from the one to the other; and this narrow fold being followed to the right was seen to broaden out and to be bounded by the duodenum and jejunum on the one side, and by the cœcum and ileum on the other: in fact it was placed at the neck of the primary loop of the intestine.

It appears clearly from these observations that the statement that at a certain period of development there is a mesocolon quite unconnected with the walls of the sac of the great omentum is true with regard to the sigmoid flexure, descending colon, and precisely one half of the transverse colon. But the right half of the transverse colon and the whole of the ascending colon are produced by the elongation of a part of the primary loop of the intestine; the neck of that loop being formed in the mesial plane by the pyloric end of the stomach and the middle of the transverse colon, while the gastric curve and that which extends from the middle of the transverse colon down to the rectum may be not inaptly considered as subsidiary loops placed one above and the other below the primary loop. It is quite manifest that the peritoneum passes directly across the neck of the primary loop, and closely connects the colon to the pyloric part of the stomach in the early stages of development as

it does at a later period. If this direct union of the stomach and colon be supposed to extend gradually to the left of the middle line, which it may very easily do by the peritoneum in that direction growing less rapidly than the surrounding parts; and if at the same time the inferior layer of the mesocolon and the sac of the omentum continue to grow, there will thus be produced the adult peritoneal relations of colon and stomach as usually described. It is more likely that this should be the method of growth than that adhesions should subsequently take place as has been suggested; for, as far as is at present known, the adhesion of serous surfaces only occurs as the result of pathological changes.

On the whole, I have little hesitation in thinking that the old description of the peritoneum, corresponding as it does with the condition ordinarily found in the adult, is that which should be preferred; but, at the same time, it is highly important that the original independence of the walls of the omental sac and the mesocolon, as well as the occasional persistence of that condition, should be pointed out in text-books professing to give a full account of the subject.

NOTES ON THE MYOLOGY OF VIVERRA CIVETTA.

By C. W. Devis, Esq. *Queen's Park, Manchester.*

The following memoranda on the Myology of Viverra Civetta are the result of an examination of a young female. The position occupied by Viverra, between the two great sections of the Carnivora, increases any interest attaching to the peculiarities of the species which may be taken as the type of its family.

The upper and lower regions of the trunk are invested with a moderately strong *Panniculus Carnosus*, which, dorsad, has a powerful attachment to the dense aponeurosis at the base of the tail. At the axilla it communicates with the Latissimus Dorsi by several fleshy slips; and on the inner side of the arm and forearm it is continuous with the aponeurotic sacs of the muscles. Under the throat it assumes somewhat of the general appearance of a Platysma Myoides. A thin fascia, giving rise to broad muscular fibres, runs from over the ligamentum nuchæ downwards and forwards to the posterior third of the mandible and to the integument of the face, leaving the laryngeal and digastric spaces almost uncovered; a similar layer comes up from the manubrial and clavicular regions and meets the former in front of the larynx. The pannicle is more closely adherent to the skin in this neighbourhood than elsewhere.

Trapezius.—The relations of this muscle present their usual complexity in the Carnivora. It rises from the whole length of the ligamentum nuchæ, forming a thin broad sheet expanded without a break over the side of the neck. Along its lower edge it blends with the sternal division of the sternocleido-mastoideus; and, above, overlies, as usual, the acromio-trachelien, except at the posterior portion of the latter muscle. The insertion of the posterior division of the Trapezius is into the spine of the scapula and into the fascia upon the upper part of the Infra-spinatus. Over the scapulo-humeral articulation it may be said to originate an accessory flexor of the fore-limb essentially

different from a Masto-humeralis. This rises directly from the Trapezius proper as a moderately broad and strong slip, which runs down the arm in front of the Biceps and is inserted into the radius rather higher than the bicipital insertion and in common with the Brachiæus Anticus—its connection with the Trapezius was on the one side effected by a tendinous raphe, delicate but obvious; on the other side the fibres of the two muscles were confluent. Near to the inner side of this attachment a slip passes from the Trapezius over the clavicular space to be inserted into the side of the first sterneber.

Sternocleido-mastoideus.—The chief bulk of this muscle consists of the sternal fascicle, which, at its upper edge, blends, as before mentioned, with the Trapezius. The clavicular bellies (one of which is very small) run in mutual contact, quite separate from the sternal, and are inserted together into the rudimentary clavicle.

Rhomboideus.—Notwithstanding the extension of the neck, its support is unaided by an Occipito-scapularis. The Rhomboideus derives its anterior portion from over the middle of the neck as a thin cuneiform layer, and thence its origin passes backwards to the second dorsal vertebra. It has a thick fleshy insertion into the fore part of the base of the scapula.

The *Acromio-trachelien* rises by a strong tendon from the posterior and lower edge of the pleurapophysis of the atlas, and is inserted fleshy into the root of the acromion. About midway it blends imperfectly with the Rhomboideus, remaining however separable from it. Besides its scapular attachment it is gradually resolved into the aponeurosis of the Spinati.

Trachelo-mastoideus.—This rises from the neurapophyses of the last four cervical and first dorsal vertebræ, and is implanted by a long and strong tendon into the mastoid. The *Complexus* rises from the neurapophyses of the vertebræ from the fourth cervical to the third dorsal inclusive, and by a distinct slip from the neural spine of the third dorsal;—it has the usual insertion. In the occipital group, the strength of the *Obliquus Cap. Inf.* is remarkable, while the *Obl. Cap. Sup.*, which rises from the edge of the pleurapophysis of the atlas, is comparatively weak. The *Rectus Cap. Posticus* presents three

divisions—the first, rather thin, flat and triangular, rising from the neural spine of the second cervical vertebra, and inserted into a shallow fossa beside the occipital spine; another weak one from the spine of the axis to the occiput as usual; and a third from the spine of the atlas to the occiput.

The *Spinalis Colli*, large, strong and fleshy, rises from the sides of five dorsal neural spines, runs over and is attached to those of the cervical vertebræ, and is inserted into the posterior part of the spine of the atlas alongside the attachment of the ligamentum nuchæ. At each vertebra it receives a slip from the Longus Colli.

Retrahentes Auris.—There are three separate muscles concerned in this motion of the ear. One superficial, rising from the aponeurosis of the cervical muscles with a direct backward action; one attached to the Occipito-temporalis at the middle of the occipital ridge and inserted with the first into the upper part of the conch; the third, broader and stronger, from the middle and lateral parts of the same ridge is inserted into the lower part of the conch—from this last a strong slip descends between the conch and the parotid to the root of the ear.

The *Masseter* has nothing remarkable in its attachments. Its bulk, though less proportionally than in Mustela, is yet much too great for the masseteric fossa—the superficies of the mandible does not indicate the actual power of the muscle which overlaps it both below and behind.

Sterno-hyoideus.—The individuality of this muscle ceases before it reaches the sternum, its fibres being interrupted at about one third of their length therefrom by a transverse tendinous line. At this point joins on the *Sterno-thyroideus*, a very slender round muscle implanted into the side of the upper part of the thyroid cartilage. The *Omohyoid* is absent. The *Stylo-hyoid* is thin and flat, with the usual relations. The thick, strong and roundish *Digastric* is inserted into the hinder half of the mandible. A feeble *Hyoglossus* turns forward from its ordinary attachment and plays over the arch of the hyoid cornu as over a pulley.

Deltoid.—Of the two fascicles of this muscle one, much larger and stronger than the other, proceeds from all the lower

edge of the acromion, but chiefly from the anterior and larger process; it has a broad carneo-tendinous insertion into a deltoid ridge commencing below the insertion of the Infra-spinatus. The other division is small, and rises from the aponeurosis of the Infra-spinatus; its weak triangular belly has insertion by a thin tendinous band into the lower side of the tendon of the larger portion.

Both the *Supra* and *Infra-spinatus* are remarkable for their strength, especially the tendon of the latter. The *Subscapularis*, on the contrary, is but feeble, the edges of its belly falling short of the circumference of the bone; it has however a strong tendinous insertion as usual.

Serratus Magnus.—This and the *Levator Scapulæ* form a single muscle. Taken in conjunction they rise from the pleurapophyses of the third cervical vertebra and of the succeeding vertebræ to the eighth rib inclusive. The portion rising from the last three ribs is folded upon itself and attached to the dorsal vertebræ by a slight tendinous fascia so as to resemble a posterior portion of the Rhomboideus. The fold is brought round the posterior angle of the scapula to the front.

The *Scalenus Posticus* rises from the third, fourth and sixth ribs, and is inserted by two small tendinous fascicles into the fourth and fifth cervical vertebræ, near, or rather upon, their bodies. The *S. Medius*, rising tendinously with the Posticus, is inserted fleshy into the first rib. The *S. Anticus* runs from the side of the body of the penultimate cervical vertebra to the first rib above the preceding. Two small bundles, rising from the pleurapophysis of the last cervical vertebra and also inserted into the first rib, fill up the angle. The cervical plexus passes under all the Scaleni. Slight indications of a *Serratus posticus inferior* are presented by two slips rising from the dorsal aponeurosis and inserted fleshy into the heads of the penultimate pair of true ribs.

Splenius—much as usual. The *Splenius Capitis* seems to be represented by a slight thinning in the two portions of the muscle and a very slight tendinous insertion over the side of the atlas. The cervical continuation of the *Sacro-lumbalis* is effected by fleshy bellies between each pleurapophysis as far as the atlas.

Pectoralis Major.—At the posterior part of its origin, which commences at the third sternocostal joint, this muscle is feeble, but it acquires some thickness at the manubrium: it is inserted broad and fleshy into three-fourths of the length of the upper and fore side of the humerus. *Pectoralis Minor.*—In this muscle three portions are distinguishable. The first, rising from the sternocostal articulations from the third to the eighth inclusive, posteriorly but not inferiorly to the Major, is inserted into the fossa on the inner side of the head of the humerus by a thick carneo-tendinous insertion. The second, rising from the xiphoid, is inserted into the head of the humerus below the preceding. The third division rises thin from the abdominal aponeurosis, and is inserted by a slight tendinous band below the second portion.

Latissimus Dorsi, originating as usual, is inserted by a broad tendinous band into the ridge below the fore and inner part of the head of the humerus beneath the biceps. The lower edge of the tendon is much the stronger, and is folded upon itself. To the upper edge the *Teres Major* has a fleshy attachment; to the tendinous margin below the Omoanconeus is attached just before the commencement of the tendon proper. The *Omoanconeus*, rising as above, is not inserted into the olecranon, but is attached to the aponeurosis round the inner edge of the elbow, and finally merges into that of the inner muscles of the fore-arm.

The *Coracobrachialis* consists of the short portion only. It rises by a long tendon from the rough surface on the anterior edge of the neck of the scapula, and passes downwards and backwards over the joint to a thick and fleshy insertion in the neck of the humerus. The Coracobrachialis and the Biceps may almost be said to rise together, the interval between their tendons being scarcely appreciable.

Triceps.—The first or long head rises from all the inferior costa of the scapula, but the origin is especially strong at the cervix. The short head on the outer side of the humerus is strong. The third head is as usual, but has more intimate union with the Anconeus than with the other divisions of the Triceps. Taken altogether the Triceps constitutes a very broad

and strong muscle. If the name *Brachiæus posticus* were not given to the whole Triceps, it would be applicable to a fascicle which rises tendinously opposite to the insertion of the Latissimus Dorsi and from the whole of the humerus below it, and is inserted, broad and fleshy, into the inner side of the olecranon.

The *Brachiæus Anticus,* a strong and fleshy muscle, rises from the back and outer side of the humerus close under the head, and over the outer aspect of the bone as far as the Sup. Rad. Long. It is joined by the tendon of the accessory flexor before mentioned, and with it is inserted by a broad tendon into the lower side of the ulna below the joint, a little above, and to the outside of the insertion of the Biceps.

The *Supinator Radii Longus,* absent in Felis and Canis, is a long, thin, and weak muscle with the ordinary attachments.

Extensor Carp. Rad. Longus. In conjunction with the *Brevis,* from which it is inseparable, it has a very strong origin from the ridge above the outer condyle, and from the outer and anterior part of the joint; also from the adjacent part of the radius. Its principal tendon goes to the middle of the metacarpal of the third digit; another smaller tendon from it is inserted into the base of the metacarpal of the index. The *Extensor Dig. Communis* and *Extensor Carp. Ulnaris* are as usual; an Extensor of the fourth and fifth digits, which sends no tendon to the third digit, as in the dogs and bears, rises and runs alongside of the Ext. Carp. Uln., but is quite distinct from it throughout its course. A slight fleshy belly also rises from the outer and posterior edge of the Ulna, and sends down a slender tendon, which passes through a special trochlear loop. The insertion of this tendon was not satisfactorily determined.

Palmaris Longus, a fusiform muscle of moderate size. It rises by a slender tendon from the back of the inner condyle of the humerus, swells into a thin belly, which again gives rise at about two-thirds of its length to a thin flat tendon. This expands over the palm, and is obscurely divided over the second joint of the digits, a portion of it going to each of the middle digits.

The *Flexor Sublimis* cannot be said to be wanting. It rises

by two small heads, one from the middle, the other from the outer side of the Profundus; their tendons are intimately connected with the Palmaris, and are very indistinctly perforated; their insertion is into the substance of the Palmar cushions. The Sublimis is a very weak muscle, and has the appearance of a mere off-set of the Profundus, rising throughout from the tendinous fascia on the outer part of the belly of that muscle. Herein it differs from its correspondent in both dogs and bears, since in these animals it is in intimate connection with the Palmaris. The *Flexor Carp. Radialis* has no origin from the ulna. *Flexor Carp. Ulnaris.*—At its origin this muscle is in combination with the Flex. Dig. Profundus by means of a median tendon common to both. It consists of two distinct fascicles, one thin, almost aponeurotic, rising from the ulna near the olecranon, the other larger and fleshy, as a Flex. Carp. Uln. Internus, and forming part of the Flex. Prof. for one-third of the length of its belly, it continues fleshy to its insertion. The two divisions run with separate bellies to a common insertion into the Pisiforme. The Flexor Dig. Profundus has four heads—two of them lateral—one of these has a thin fleshy origin from the radius, from the middle upwards; the other similarly from the ulna—two of them condylar—one of these thick and fleshy, constituting the chief bulk of the muscle, rises from the back of the inner condyle of the humerus; the other rises beneath the last quite distinctly, forming a separate belly, whose tendon runs down to the carpus, and there unites with those of the other divisions into a common mass, in which, however, the line of fusion between the middle and outer tendons remains distinguishable. Again separating, a tendon proceeds through a ligamentous loop to each toe, the middle tendons being furnished by the head from the inner condyle, that of the little toe from the belly rising from the ulna, that of the pollex from the radial division. The whole muscle is of very great strength.

The *Abductor*, *Adductor*, and *Opponens Pollicis* are all distinctly developed. The *Pronator Quadratus* of unusual strength. The *Lumbricales* distinct, but rather weak. A moderately thick *Accessorius* rises on the radial side from the lower border of the

Lig. Ann. Intern., and quickly sends off a thin but distinct tendon, which passing across the palm is inserted into the sheath of the Flex. Profundus tendon going to the little toe.

The *Pyriformis* is a single but strong muscle inserted into the summit of the great trochanter.

The *Gemelli* are large and inseparable, with a strong insertion beneath the sacrosciatic ligament. *Glutæus Externus.*—This is a powerful muscle, but less so proportionally than in the bears; it is covered and supported by a dense aponeurosis, from which the fore part of the muscle has origin; the fibres from this source being inserted the lowest on the back of the femur. Below this the succeeding part of the Externus rises from the aponeurosis covering the Glutæus Medius, then from that covering the muscles of the sacrum and from the first two caudal-spines and pleurapophyses. This portion, though not separable, is obviously distinct, the line of demarcation being evident on the lower surface, and the insertion distinct from and above that of the next, which rises from the pleurapophysis of the third caudal vertebra, and goes straight down to its insertion. The attachment of this portion is prolonged half way down the femur; its strong strap-like fascicle of fibres must render it an efficient depressor of the base of the tail.

Glutæus Medius.—A muscle rising thick and fleshy from the anterior part of the iliac fossa, with the ordinary insertion; from the fore part of the muscle a fascicle may be separated, and its insertion traced to a distinct tendon implanted into a fossa on the outside of the Trochanter.

Glutæus Internus.—The two portions into which this muscle is divisible are very distinct in origin. The anterior division rises from the convex iliac surface in front of the acetabulum and capsular ligament, and is inserted into the fore and upper point of the great trochanter. The posterior rises from the sacroiliac fossa; covered by the pyriformis it appears to come over the ischiadic notch; it is also attached to the ischium—its insertion is broad and tendinous into the back and inner part of the great trochanter. The broad strong tendon of the Obturator Internus coming from within the pelvis and passing over its outer surface is very conspicuous.

The *Rectus* and *Gracilis* present the ordinary relations.

Semi-tendinosus.—This has its insertion prolonged downwards to the heel. Beside the usual head from the external and inferior aspect of the tuberosity, it derives a long slip from the pleurapophysis of the third caudal vertebra behind the caudal origin of the Glutæus Externus.

Semi-membranosus.—From a thick and fleshy origin strengthened by a strong tendon from the tuberosity above and before the origin of the preceding muscle, the Semi-membranosus expands into a broad fleshy mass. Besides its general insertion into the fascia of the leg, which continues its action distinctly down to the heel, it has a ligamentous attachment to the sesamoid of the Gastrocnemius, and a well-marked tendinous attachment to the condyle of the femur and head of the tibia close under the internal ligament.

The *Biceps* consists of a single broad, strong, and fleshy head from the arched edge of the ischium; it is inserted fleshy into the tibia below the head, and by tendinous fascia over the knee—below it joins the tendon of the Gracilis.

To the inner surface of the Biceps is attached by cellular tissue a muscle which accompanies it for the greater part of its course. It is easily raised from its bed, and then appears as an extremely long and narrow ribbon of fleshy fibres. Traced from its delicate tendinous insertion into the tibia beneath the attachment of the Biceps it runs upwards, and quitting the Biceps near its origin terminates abruptly in a fine tendinous band within the cellular tissue and membrane covering the sacral plexus. Some tendinous fibres are also distinctly prolonged to the lymphatic gland here situated, and others seem to be connected with the fascia dipping in from the coccygeal muscles.

The *Pectinalis* is small. The *Vasti* become confluent before their insertion into the patella. The lower edge of the *Triceps* has a strong insertion into the sesamoid of the Gastrocnemius.

Gastrocnemius.—The inner division of this muscle scarcely deserves the separate name of Soleus. It rises partly by a strong tendon over the upper side of the sesamoid, partly by fleshy fibres from the angle of the joint. The outer head, which

rises almost entirely from its sesamoid, sends its chief bulk to unite normally with the inner division. A portion of it however separates again and forms a belly ending in a distinct tendon, which crossing the tendo-Achillis proper is inserted not into the calcaneum but into the tendinous aponeurosis covering the end of that bone.

Plantaris.—Rising tendinous and fleshy from a tuberosity below the back of the head of the Fibula, thickens into a fusiform belly which merges into the tendon of the inner head of the Gastrocnemius.

The *Tibialis Anticus* is strongly developed. The *Posticus* rises carneo-tendinously and by fleshy fibres from the belly of the Flex. Long. Profundus, and from the Tibia as far as the edge of the Poplitæus, and thence about half way down; it is inserted strongly into the naviculare.

The *Peronæus Brevis* rises from the anterior tuberosity of the fibula, distinctly continuing separate from the Longus; its tendon passes across the sole and is inserted with that of the Longus into the root of the hallux.

The *Flexor Brevis Dig.* sends three perforated tendons to the middle toes; these are implanted on the inferior surface of the base of the last phalanx.

Flexor Brevis Hallucis.—This muscle, fleshy throughout and distinct, runs from the tarsus to the outer side of the sesamoid.

The Flexor Long. Hall. rises by a slender carneo-tendinous origin from the head of the tibia at its junction with the fibula; it forms a fusiform belly whose tendon joins the mass of the Flex. Com. Profundus on the sole and then separates again for its usual insertion.

The *Flexor Com. Profundus* rises with the Flex. Long. Hall. carneo-tendinously and fleshy from the whole length of the fibula and tibia, with the ordinary insertion.

Extensor Proprius Hallucis.—This is a very slender cord-like belly rising fleshy from the inner and front edge of the tibia about its middle; its tendon terminates in a thin attachment to the hallux and fourth digit.

Extensor Proprius Quinti Digiti.—Rises fleshy from the middle of the outer surface of the head of the fibula, and for a

short distance down it. Above the malleolus it sends down alongside the tendon of the Peroneus Longus a slender tendon which runs along the upper and outer side of the tarsus and fifth metatarsal; near the end of the latter it terminates bluntly without insertion into the bone.

Extensor Digitorum Communis.—A feebly-developed though rather complex muscle. It rises by a long tendon from the fore and outer surface of the outer condyle of the tibia near the articulation, and passes over the joint in a groove between the fibula and tibia. At about one-third of its course its belly divides. One portion continues fleshy a short distance and then gives off two slender tendons: of these, one, joined to the rest by easily separable tissue, runs downwards to the second digit; the other is united to the rest over the metatarsus, then separates and goes to the third digit. The other belly is much the longer and sends its two tendons to the fourth and fifth digits. These tendons are slightly confluent.

Extensor Brevis.—Rises fleshy from the annular ligament and over the whole of the middle of the tarsus and metatarsus. It is inserted into the fascia covering the digits.

Abductor Hallucis.—Rises from the same place as the Flex. Brev. Hall. and is implanted into the inner part of the sesamoid.

The *Abductor* and *Flex. Brev. Min. Dig.* are represented—the former strongly.

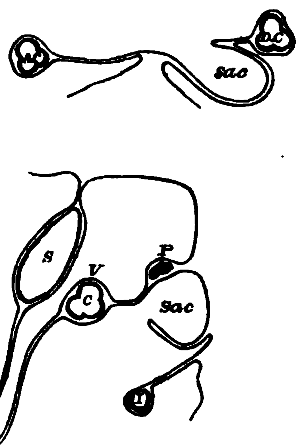
Interossei.—These are much more on the sole than between the bones. They are very large and so amalgamated as to render discrimination unsatisfactory. Together they form a strong fleshy pad under the paw.

ANATOMICAL DESCRIPTION OF A CASE OF INTRA-PERITONEAL HERNIA.

By JOHN CHIENE, M.D.,
Demonstrator of Anatomy, University of Edinburgh.

THIS abnormality was noticed in an adult male brought to the Dissecting Rooms of the University during the present session.

When the cavity of the abdomen was laid open and the great omentum, along with the transverse colon, thrown upwards only a few coils of the lower end of the ileum were visible. On tracing the small intestine upwards, it was found to disappear through an oval opening, measuring 2¼ inches by 1½, situated in the anterior surface of the descending meso-colon on a level with, and about 2 inches to the left of the body of the 3rd lumbar vertebra. The edge of the opening was free except



Plan of the Peritoneum.

The transverse section is made on a level with the body of the third lumbar vertebra. The observer is supposed to be looking upwards. The vertical section is an antero-posterior one two inches to the left of the middle line. Sac. Hernial sac. A.C. Ascending colon. D.C. Descending colon. S. Stomach. C. Colon. P. Pancreas. I. Small intestine. V. Lesser cavity of peritoneum above colon.

superiorly and internally where the descending meso-colon was directly continuous with the mesentery of the intestine as it passed into the sac. When the lesser cavity of the peritoneum was laid open by dividing the layers of the great omentum between the stomach and transverse colon, the meso-colon extending upwards and backwards and enclosing the pancreas so as to form a peritoneal ligament between it and the posterior abdominal wall was exposed. When this was divided immediately below the pancreas, a sac of an oval shape, measuring 6 to 8 inches in its longest or vertical diameter and containing the coils of the jejunum and upper portion of the ileum was opened into. It lay in the left lumbar region. It was bounded, superiorly by the pancreas, anteriorly by the splenic flexure and commencement of the descending meso-colon, posteriorly by the parietal peritoneum which here covered the left kidney and posterior abdominal wall. Its internal surface was smooth and glistening. It was formed by an invagination of the descending meso-colon through the opening already described. No evidence of a rupture of the peritoneum was visible. The intra-hernial bowel lay free except at a point close to the orifice superiorly and internally where it was attached by its mesentery to the wall of the cavity. The intestine could be drawn entirely out of the cavity through the opening. Seven feet of the ileum were extra-hernial, its mesentery was continuous both on its anterior and posterior aspects with the mesentery of the bowel within the sac. There were no signs of constriction of the bowel at any part. The other viscera and the peritoneum in relation to them were normal. The mesenteric vessels were also normal. The left colic artery wound round the lower margin of the opening from right to left to reach a higher level and anastomose with the middle colic artery.

No history could be obtained of this case, but from the healthy state of the entire gut and from the absence of any signs of peritonitis there is no doubt that little or no inconvenience must have arisen from this peculiar arrangement of the intestinal canal. Cases precisely analogous to the one just described in which the sac is an *invagination* of the peritoneum

are seemingly very rare. Dr Peacock[1] records an example; it occurred in a man, æt. 30, who died of typhus fever in the Royal Free Hospital and at the post-mortem examination a sac, formed by the meso-colon, and containing the jejunum and all the ileum except the lower two inches, was discovered. In other particulars it closely resembled the case I now record. There were no symptoms referable to the abdomen.

Sir Astley Cooper[2] describes the dissection of two forms of intra-abdominal hernia; in one the hernial bowel lay *between* the layers of mesentery having escaped through an opening in its posterior surface, in another the orifice into the sac was in the meso-colon the bowel lying *between* its layers, the former he names a "Mesenteric Hernia," the latter a "Meso-colic Hernia;" in neither were any abdominal symptoms noticed. He adds that probably in both examples a slight torpidity of the bowels may have been present. He cannot say whether they are congenital or due to a sudden strain or other violence rupturing the peritoneum.

Prof. Monro[3] mentions an example in which the bowel escaped through a preternatural opening in the mesentery, strangulation followed by death was the result.

Sir Wm. Lawrence[4] says he has seen two instances of this abnormality, in one the sigmoid flexure, in another the broad ligament of the uterus formed the sac. I cannot gather from his account whether strangulation was the result of either of these complications.

Dr Peacock (op. cit.) described and showed drawings of another example at the same time that he recorded the case mentioned above. The patient, æt. 27, was admitted into the Edinburgh Royal Infirmary suffering from all the symptoms of internal strangulation followed by death after 42 hours illness. On examination the small intestines were found enclosed in a sac formed *between* the layers of the left meso-colon. The ileum passed out of the sac two inches above its junction with the cœcum and at that point the canal of the intestine

[1] *Trans. Path. Soc.* Lond. Vol. II. p. 60.
[2] *Anatomy and Surgical treatment of Crural and Umbilical Hernia*, p. 73.
[3] *Observations on Crural Hernia*, 1803, p. 12.
[4] *A Treatise on Ruptures*, 1838, p. 630.

was contracted, the intestinal coats thickened, intensely inflamed and gangrenous.

There is another variety of internal hernia in which the lesser cavity of the peritoneum forms the sac the bowel entering it through the foramen of Winslow. Jobert[1] describes a case in which death occurred from strangulation.

Dr John Wilson Moir of Edinburgh has given me notes of another example, which was observed last year in the Hospital at Vienna at the post-mortem examination of a patient, who died with symptoms of internal strangulation. On opening the abdomen the small intestine was invisible, on closer inspection it was found to have passed into the lesser cavity of the peritoneum through the foramen of Winslow.

Prof. Gruber of St Petersburg[2] also has described cases of internal hernia and made reference to others.

The Pathology of Intra-abdominal Herniæ is obscure. They may, I think, with advantage be classed under three distinct heads.

1st. Those in which an invagination of the peritoneum forms the sac. In them the bowel within the sac is *intra-peritoneal.* They are probably congenital malformations, or arise soon after birth, a congenital weakness of the peritoneum forming the meso-colon or mesentery being the proximate cause; in them I can find no deaths from strangulation. The first of Dr Peacock's cases, and the case which I record are examples of this class.

2nd. Those in which either from congenital malformation or more probably from rupture of one layer of the peritoneum an opening is formed through which the bowel escapes from the cavity of the peritoneum and becomes related to its external serface. They, although intra-abdominal, are *extra-peritoneal.* The view that in the majority of instances the opening is due to rupture from violence or a sudden strain, is favoured by the fact that the peritoneum is a shut sac and that those portions of the peritoneum in which the hernia occurs, are developed as a continuous membrane. Sir Astley

[1] *Traité des Maladies Chirurgicales*, Vol. I. p. 522.
[2] *Canstatt Jahresbericht*, 1862, p. 353.

Cooper's dissections, Sir Wm. Lawrence's and the last of Dr Peacock's cases are instances of this variety.

3rd. Those in which the sac is the lesser cavity of the peritoneum the opening into it being the foramen of Winslow, as in Jobert's and Dr Moir's cases.

CASE OF AN OBLITERATED RIGHT INTERNAL JUGULAR VEIN. By JOHN CHIENE, M.D., *Demonstrator of Anatomy, University of Edinburgh.*

THIS abnormality occurred in the body of an adult female dissected in the month of January, 1868.

On laying open the carotid sheath on the right side a fibrous cord-like structure was found immediately external to the carotid artery, which from its position and connections was obviously the obliterated internal jugular vein. Below, it joined the subclavian vein behind the right sterno-clavicular articulation to form the right innominate vein, above, it ended in the right lateral sinus. A surgical probe could be passed from the sinus downwards into the vein for 2½ inches; it could also be passed upwards from the innominate vein for three-fourths of an inch. The intervening portion was impervious. No veins joined it in any part of its extent. The right external jugular was small. There were three large veins in relation to the vertebral artery, one issuing from the foramen in the transverse process of the sixth cervical vertebra, the others from the corresponding foramen in the seventh vertebra; they joined the subclavian vein. The right anterior jugular was large; it received the occipital, temporal, internal maxillary, facial and superior thyroid veins; it was superficial to the depressors of the larynx, but passed beneath the sterno-mastoid, and, after the internal mammary and transverse cervical veins had joined it, emptied itself into the commencement of the right innominate. A large communicating vein, nearly as large as the little

finger, connected it, immediately above the sternum, with the anterior jugular of the opposite side. The right superior thyroid vein inosculated freely with the other thyroid veins in the substance and on the surface of the thyroid body. The right inferior thyroid, fully half an inch in diameter, lay over the *centre* of the trachea in its course to join the left innominate an inch from its termination. The right lateral sinus was normal. The right mastoid foramen was nearly equal in size to the foramen ovale in the sphenoid bone. No peculiarity was noticed in the arteries. The veins on the left side of the head and neck were normal.

The majority of the veins above described were filled with injection, and on opening the right auricle the foramen ovale was seen to be widely patent, readily admitting the point of the finger. As the arterial system had been injected from the femoral, the injection had passed through this aperture from the arterial to the venous side of the heart, and thence into the veins. The blood must principally have been removed from the cavity of the cranium by the left internal jugular, the anastomosis between the ophthalmic and facial veins and by the mastoid vein, which had probably joined the occipital vein, but as it had been cut across in reflecting the scalp for the removal of the brain, I cannot speak precisely on this point. The blood from the face and external parts of the head had found its way to the thorax by the anterior jugular, the thyroid plexus of veins, and through free anastomoses with the veins on the left side of the head and neck.

Inflammation of the vein followed by the formation of a clot, the absorption of that clot, the subsequent obliteration of the vessel and consequent enlargement of the collateral venous circulation, is a sequence of pathological phenomena to which in all probability the appearances found on dissection may be attributed.

The presence of a large superficial transverse vein, and also of a deeper vessel of considerable size, in the *middle line* of the neck, in close contact with the trachea, would, had tracheotomy been required in this individual, have greatly impeded and rendered difficult the proper performance of the operation.

ON THE CONNECTION BETWEEN CHEMICAL CONSTITUTION AND PHYSIOLOGICAL ACTION; WITH SPECIAL REFERENCE TO THE PHYSIOLOGICAL ACTION OF THE SALTS OF THE AMMONIUM BASES DERIVED FROM STRYCHNIA, BRUCIA, THEBAIA, CODEIA, MORPHIA, AND NICOTIA. By ALEXANDER CRUM BROWN, M.D., D. Sc., F.R.S.E., and THOMAS R. FRASER, M.D., F.R.S.E. (Abstract of a Paper read before the Royal Society of Edinburgh, *Jan.* 6, 1868).

IT is obvious that there must exist a relation between the chemical constitution and the physiological action of a substance, but as yet scarcely any attempts have been made to discover what this relation is. All that is known is, that as a general rule (with some striking exceptions) the compounds of certain elements, such as mercury or arsenic, and of certain radicals, such as cyanogen, possess (when soluble in water, or the fluids of the body) a physiological action which appears to be of the same kind for the whole series of compounds of each element or radical.

Although we cannot obtain a rational explanation of the connection between the chemical and physiological characters of a substance until we know more of the *modus operandi* of poisons, it might be supposed that a careful examination and comparison of known facts would lead to the discovery of some empirical law or laws by means of which we could deduce the action from the chemical constitution. Unfortunately, however, we know next to nothing of the constitution of the majority of those substances (such as the natural alkaloids) the physiological action of which has been most carefully investigated. It appears, therefore, to us that there is more hope of arriving at some definite conclusion by studying the changes produced in the action of physiologically active substances by performing upon them certain well-defined chemical operations which in-

troduce known changes into their constitution, but do not break up the molecule. To use a mathematical analogy, if we represent the constitution by C and the physiological action by Φ, Φ is some unknown function of C, say fC; to discover this we produce a known change on the constitution by which it becomes $C+\Delta C$, and examine the corresponding change of physiological action which has become $\Phi+\Delta\Phi$. We thus obtain the relation between ΔC and $\Delta\Phi$ or $\Delta f.C$, and by sufficiently varying C and ΔC, we may hope to get at all events an approximate solution of the problem. Operations which introduce a known change into the constitution without breaking up the molecule are of two kinds, (1) replacements (or more properly displacements), and (2) additions. As this paper is not addressed exclusively to chemists, we think it right to give here such an explanation of these terms as may make what follows generally intelligible.

When one or more constituents of a chemical substance are exchanged for one or more new constituents, the process is called replacement; thus when zinc acts on sulphate of copper producing metallic copper and sulphate of zinc, the copper is said to be replaced by the zinc[1]; and when carbonate of soda acts on sulphate of lead producing carbonate of lead and sulphate of soda, sodium is said to be replaced by lead in the carbonate, and lead by sodium in the sulphate[2]. Similarly, when pentachloride of phosphorus acts on water producing oxychloride of phosphorus and hydrochloric acid, the chlorine is said to replace oxygen, and *vice versâ*[3]. The molecule thus produced may be very different from the original one, but the new constituents occupy the place and perform the functions of the old, though often in a very different way.

When new constituents enter a molecule without displacing any thing already there, the process is called addition; thus hydrochloric acid (HCl) is added to ammonia (NH_3) producing chloride of ammonium (NH_4Cl). In the same way iodide of methyl (CH_3I) is added to ammonia (NH_3) producing

[1] $CuSO_4 + Zn = ZnSO_4 + Cu.$

[2] $Na_2CO_3 + PbSO_4 = PbCO_3 + Na_2SO_4.$

[3] $PCl_5 + H_2O = POCl_3 + 2HCl.$

hydriodate of methylamine ($NH_3(CH_3)I$). To take another example, chlorine (Cl_2) is added to olefiant gas (C_2H_4) producing Dutch liquid ($C_2H_4Cl_2$). Here the new constituents do not represent anything which was in the original molecule; the place they now occupy was, in a certain sense, vacant, and the new substance belongs to a different order of compounds from the old. The examples given above illustrate two different (or at least apparently different) ways in which a substance may be susceptible of addition, (1) by the increase of the external chemical activity of an atom (in the examples, N, which before the addition is united to three equivalents and after it to five), and (2) by the increase of the external chemical activity of a group of atoms (in the example C_2, which before the addition is united to four equivalents and after it to six). In the latter case the substance to which addition can be made is said to be 'condensed.' We shall, however, apply the term 'condensation' to susceptibility of addition in either way, and distinguish the two cases as *intra-atomic* and *extra-atomic* condensation. The degree of condensation is measured by the extent to which the process of addition can be carried; thus carbonic oxide, ammonia, olefiant gas, allylic alcohol, &c. are of the same degree of condensation, each being capable of taking up *two* additional equivalents. Hydrocyanic acid, acetylene, diallyl, &c. are twice as condensed as the former group, being capable of taking up *four* additional equivalents.

In commencing our investigation of the change produced by chemical operations on the physiological action of substances, we had thus two distinct kinds of chemical operation to choose between. We have selected as the first subject of study the effect of chemical addition; our reasons for doing so will be best explained by a short statement of what was already known in this department. As a general rule replacement does not appear to produce any marked change in physiological activity. The exceptions to this are of three kinds, (1) where the replacement changes the physical character of the substance, so as to render it more or less easily absorbed into the system, thus acetate of lead is poisonous, sulphate of lead is inert; (2) where the activity depends on direct local action, thus sulphuric acid

(H_2SO_4) and caustic soda (NaHO) are both poisonous, while sulphate of soda (Na_2SO_4) and water (H_2O) are not; (3) where the replacement removes or introduces the atom or radical upon the presence of which the activity depends, thus acetate of lead is poisonous, acetate of soda not. Besides these exceptions there are several isolated cases of change of activity produced by replacement, such as the very different action of the two classes of metallic cyanides.

In order to discover the physiological effect of addition we must compare the action of the substance before and after the addition is performed upon it; and that this may be done fairly, three conditions must be fulfilled; (1) that the two substances should be equally capable of absorption into the system; (2) that the process of addition can neither be performed nor reversed in the system; and (3) that neither substance has such a powerful local action as would prevent our observing its general or remote effect. These conditions exclude from our consideration a very large number of cases. Thus we cannot compare the action of the ferrous or arsenious compounds with that of the ferric or arsenic, on account of the readiness with which the former are oxidized, and the latter reduced; we cannot compare the action of corrosive sublimate with that of calomel, because the one is so much more readily absorbed than the other; we cannot compare the action of anhydrous sulphurous (SO_2) with that of anhydrous sulphuric acid (SO_3) on account of the violent local action of the latter; and, to content ourselves with another example, we cannot compare the action of an alkaloid with that of its salts, because the alkaloid is converted into a salt in the stomach, and the salt is probably converted into the alkaloid in the blood and other alkaline fluids of the body. After making all the deductions required in order that the three conditions stated above may be satisfied, there remains, however, a very large number of cases in which the action of a substance before and after addition may be fairly compared. We subjoin a list of some of the more important of these, in which the physiological action has been studied by previous observers. The first column contains the names and formulæ of the substances before addition, the

second the atoms or groups added, and the third the names and formulæ of the bodies produced.

I.	II.	III.
Carbonic oxide CO	O	Carbonic acid CO_2
Hydrocyanic acid HCN	H_4	Methylamine CNH_5
Arsenious acid $As_2O_3[HAsO_2]$	$(CH_3)_2$	Kakodylic acid $AsC_2H_7O_2$
Strychnia $C_{21}H_{22}N_2O_2$	$CH_3(HO)$	Methyl-strychnia (hydrate) $C_{22}H_{26}N_2O_3$
Brucia $C_{23}H_{26}N_2O_4$	$CH_3(HO)$	Methyl-brucia (hydrate) $C_{24}H_{30}N_2O_5$

It will be observed that all the substances in the first column are highly poisonous, while those in the third column are stated to be inert, or nearly so, their action, when they have any, differing entirely from that of the bodies from which they are derived.

Such a connected view of these hitherto isolated facts not unnaturally leads to a suspicion that *condensation* (which is diminished by addition) is in some way connected with physiological activity, which seems also to be diminished, or removed, by chemical addition. This suspicion is strengthened when we observe that in a very large proportion of the cases as yet investigated, saturated bodies (that is, bodies whose condensation is 0) are inert, or nearly so.

Kakodylic acid[1], as already mentioned, is a remarkable example of this, and the salts of tetrethyl-arsonium[2] seem to be equally inert. Similarly, the salts of tetramethyl-stibonium[3] are not emetic. So that, as far as experiment goes, it would appear that the stable compounds of pentatomic arsenic and antimony have a very different and much less intense action than the compounds containing these elements as triads. The occurrence, however, of saturated substances, such as alcohol, oxalic acid, and corrosive sublimate, having a well-marked poisonous action, and of condensed substances, such as benzoic acid and salicine, which are comparatively inert, shows that condensation is not the only condition of physiological activity; but

[1] Bunsen, *Annalen der Chemie und Pharmacie*, XLVI. 10.
[2] Landolt, *Ann. d. Ch. und Ph.* LXXXIX. 331.
[3] Landolt, *Ann. d. Ch. und Ph.* LXXXIV. 49.

there can be little doubt that if the effect of condensation were discovered and eliminated, the other conditions might be much more hopefully sought for.

For these reasons we have turned our attention to the effect of chemical addition in modifying the action of poisons, and have selected, as the first subject of investigation, the addition of iodide of methyl to the natural alkaloids belonging to the class of nitrile bases[1].

As this addition removes only the *intra-atomic* condensation of the typical nitrogen, and leaves any other condensation untouched, and as the radical or radicals united to the nitrogen are in the case of all the natural alkaloids highly condensed, we should not expect, even supposing that condensation and poisonous action go together, to find the action entirely removed by this addition. The results of experiment, as will be seen from the subsequent part of this paper, confirm this expectation.

As the iodides of the complex ammoniums thus produced are, in most cases, sparingly soluble in water, we have also examined the action of the corresponding sulphates, which are very soluble.

The vegetable alkaloids to which we have applied this method are strychnia, brucia, thebaia, codeia, morphia, and nicotia.

STRYCHNIA.

Iodide of methyl-strychnium. Stahlschmidt, the chemist who discovered the methyl-strychnium compounds, has published a statement to the effect that they are inert[2]. As the sequel will show, we do not altogether confirm this assertion, but it is proper to acknowledge that our investigation arose entirely from it.

It is well known that strychnia acts on the living economy in a distinctly defined and characteristic manner, and that it is one of the most active and energetic of toxic agents. Doses varying from the one-twentieth to the one-thirtieth of a grain

[1] We have also examined the action of some of the iodides prepared by the addition of iodide of ethyl, and have found, as might have been expected, that it is the same as that of the corresponding methyl compounds.

[2] Poggendorff's *Annalen*, CVIII. 528.

rapidly produce in rabbits the most violent convulsions, and, in a few minutes, kill the animal. Few poisons have been more carefully studied, and it is now almost undoubtedly established that the phenomena produced by strychnia are due to a localization of its action on the spinal cord.

In our first experiments with iodide of methyl-strychnium, we administered, subcutaneously, a number of doses, varying in amount from one to five grains, to rabbits and dogs, but were disappointed by finding that, although our iodide of methyl-strychnium was much less active than strychnia itself, it still produced spasms and convulsions, and, sometimes, even tetanus. It was not until we had adopted certain precautions, which at first appeared unnecessary, in the process of preparation, that a body of almost absolute purity, and, therefore, nearly completely free from any trace of unchanged strychnia, was obtained. It is obvious that the greatest possible care is necessary to prevent fallacy in the case of such powerful poisons as we were examining; for a very minute quantity of the unchanged poison—that is of the poison which had escaped the chemical addition—would quickly prove its presence by special symptoms, and so either mask or seriously modify any action that might be caused by the changed substance. In the case of iodide of methyl-strychnium, the presence of 0·5 per cent. of strychnia in a dose of five grains would produce marked symptoms of strychnia-poisoning.

Having succeeded in obtaining a pure preparation, its effects on rabbits were first examined by subcutaneous injection. It was administered as a fine powder suspended in warm distilled water, in which menstruum it is but sparingly soluble, though more so than in water at the ordinary temperature. In this way, by a series of progressively increasing doses, it was found that as much as twelve grains could be given to a rabbit, weighing three pounds, without any effect whatever. Fifteen grains, however, produced serious symptoms, though followed by recovery, and death was caused by the exhibition of twenty grains. In none of our experiments, not even in the fatal cases, were the symptoms those of strychnia-poisoning: no starts nor spasms occurred, nor did stimulation give evidence

of the slightest increase of reflex activity. In fact, a condition exactly the reverse of that produced by strychnia was caused by iodide of methyl-strychnium. In place of violent spasmodic convulsions and muscular rigidity, the appearances were those of paralysis, with a perfectly flaccid condition of all the muscles. The limbs of the animal first yielded, its head gradually sank until it rested on the table, by and by, it lay in a perfectly relaxed condition, and, when death occurred, it was due to stoppage of the respiratory movements. In the autopsies further evidence was obtained to distinguish the effects of iodide of methyl-strychnium from those of strychnia. The heart was found acting with nearly its normal rapidity; the spinal motor nerves were either paralysed, or nearly so; and, in place of the early or almost immediate occurrence of *rigor mortis* that follows the action of strychnia, the muscles continued flaccid, contractile, and alkaline for many hours.

The effects of internal administration were examined by passing a gum elastic catheter down the œsophagus of a rabbit, and so injecting iodide of methyl-strychnium suspended in warm distilled water. No effect was produced by this method of exhibition, although as much as thirty grains was given at one time. This rabbit was killed, some days afterwards, by introducing, in the same way, one-tenth of a grain of strychnia into the stomach. As thirty grains of iodide of methyl-strychnium contain about twenty-one grains of strychnia, this experiment proves that the addition of iodide of methyl diminishes the poisonous activity of strychnia at least two hundred and ten times.

As iodide of methyl-strychnium is a sparingly soluble substance, it appeared proper, in order to compare the actions of strychnia and of methyl-strychnium, that the properties of the sulphate of the latter—which is extremely soluble—should be examined.

Sulphate of methyl-strychnium.—As had been anticipated, the sulphate of methyl-strychnium is a much more active substance than the iodide. One grain, dissolved in water and injected under the skin of a small rabbit, caused its death in eighteen minutes. Half-a-grain, however, produced no effect.

When eight-tenths of a grain was similarly administered to a rabbit, weighing three pounds and a quarter, symptoms of a most serious character were produced, but death did not result. Some days afterwards, one-twentieth of a grain of strychnia, dissolved in very dilute sulphuric acid, was administered to this rabbit by subcutaneous injection; and it produced symptoms of strychnia action, followed by death fifteen minutes after the injection. Eight-tenths of a grain of sulphate of methyl-strychnium contain about six-tenths of a grain of strychnia; the effect of the addition had been, therefore, to reduce the poisonous activity of strychnia at least twelve times.

When this substance is administered to rabbits by the stomach, twenty grains appears to be about the minimum fatal dose.

The symptoms that are produced by sulphate of methyl-strychnium are the same as those that are caused by the corresponding iodide. The very short account we have given of the symptoms and *post mortem* phenomena that occur after the administration of iodide of methyl-strychnium, is sufficient to suggest a close resemblance between its action and that of curare (wourali), a well-known and elaborately studied poison. In a recent publication, Professor Schroff of Vienna has indicated a resemblance of this kind between the nitrate of methyl-strychnium and curare[1]. Both substances undoubtedly produce a condition of general paralysis, but the special characteristic of curare-poisoning is that this paralysis is the result of an impairment or destruction of the function of the peripheral terminations (end-organs) of the motor nerves. It is impossible to demonstrate such an action without undertaking experiments of a special character. We, accordingly, extended our research for the purpose of examining this question.

The sciatic artery and vein were tied at the knee of a frog, and one-tenth of a grain of sulphate of methyl-strychnium, dissolved in distilled water, was injected under the skin of the back. Eight minutes afterwards, the frog was lying in a per-

[1] *Wochenblatt der Zeitschrift der k. k. Gesellschaft der Aertze in Wien;* VI. Band, 1866, pp. 157—162.

fectly flaccid state and, in ten minutes, irritation of any portion of the skin produced energetic movements of the tied limb *below the points of ligature*, but nowhere else. The sciatic nerve of the untied limb was now exposed, and on stimulating it with a weak, interrupted galvanic current, movements occurred in the tied limb only; not the slightest effect occurred in any part to which the poison had access. At the same time, the muscles were everywhere active, and freely contracted when directly stimulated. The sciatic nerve was then exposed in the tied limb, *above the points of ligature*, and on stimulating it energetic movements occurred below the knee of that limb, and there only. The heart was, at this time, acting at the rate of 50 per minute.

This experiment was repeated with one grain of iodide of methyl-strychnium, and the same results were obtained. We have, therefore, demonstrated that sulphate and iodide of methyl-strychnium produce paralysis and death by destroying the function of the motor nerve end-organs, and that their mode of action is, therefore, identical with that of curare. This conclusion is an extremely curious and interesting one. It is difficult to imagine a more decided modification in the action of any substance than has been produced by the addition of iodide or sulphate of methyl to strychnia. The striking characteristic of strychnia-action is the great and uncontrollable activity of the muscular system; that of curare, of iodide and sulphate of methyl-strychnium, and, as we shall presently see, of several other added-to poisons, is the flaccid and motionless condition caused by the impossibility of exciting muscular action through the nervous system. So opposite are their effects that physiologists look upon curare as a powerful counteragent to strychnia, while physicians have employed it with success in the treatment of strychnia-poisoning and of tetanus. It is remarkable that by so simple a process of chemical addition so thorough a change should be produced in physiological action. It has also been shewn that this addition has greatly reduced the poisonous activity of strychnia.

BRUCIA.

Brucia is a poisonous alkaloid derived from some plants belonging to the *genus* Strychnos. It possesses a physiological action exactly similar in character to that of strychnia, but less in degree.

Iodide of methyl-brucium.—In a series of experiments it was found that ten grains of iodide of methyl-brucium, suspended in warm distilled water, could be administered subcutaneously to a rabbit without any effect. Eighteen grains rapidly produced death, with exactly the same phenomena as are observed with the corresponding strychnia compound, and, therefore, without the slightest trace of those symptoms of exaggerated reflex action, convulsions, and tetanus, that are caused by brucia itself. Fifteen grains were injected under the skin of a rabbit, and produced a condition of general paralysis, from which a complete recovery had taken place in forty-five minutes after the administration. Some days afterwards, this rabbit was rapidly killed by the subcutaneous injection of one-fifth of a grain of brucia. Fifteen grains of iodide of methyl-brucium contain about thirteen grains of brucia; the addition of iodide of methyl, therefore, diminishes the poisonous activity of brucia at least sixty times. The fatal dose of brucia is about twice as large as that of strychnia; but that of iodide of methyl-brucium is about the same as that of iodide of methyl-strychnium. The latter is, however, less soluble in water than the former, and the similarity in the poisonous activity is probably due to this difference in solubility.

Some experiments were made in which this substance was administered by the stomach, and it was found that thirty grains—containing about twenty-five grains of brucia—could be thus given to a rabbit without any effect.

Sulphate of methyl-brucium.—One grain of sulphate of methyl-brucium produced no effect when injected under the skin of a rabbit. Two grains, exhibited in the same way, caused complete loss of motility, and other symptoms in no way distinguishable from those produced by the corresponding preparation of strychnia. The fatal dose of this substance for

an average-sized rabbit was found to be two grains and a half. Two grains of this sulphate contains about 1·7 grain of brucia; and as one-fifth of a grain is a large fatal dose of the latter, the addition of sulphate of methyl renders brucia at least nine times less poisonous.

It was found that twenty grains of sulphate of methyl-brucium could be introduced into the stomach of a rabbit, without the slightest symptom being produced. This dose contains about seventeen grains of brucia, and its magnitude is apparent when we recollect that about a quarter of a grain of uncombined brucia thus administered will rapidly kill a rabbit.

The addition of iodide or sulphate of methyl modifies not only the fatal dose, but also the physiological action of this alkaloid. By the same methods of investigation as were adopted with the corresponding compounds of strychnia, we have demonstrated that iodide and sulphate of methyl-brucium destroy the function of the peripheral terminations of the motor nerves—the addition having produced the same remarkable change in the action of brucia as in that of strychnia.

THEBAIA.

One of the active principles of opium possesses an action in all respects the same in character as that of strychnia or brucia. We principally owe our knowledge of the mode in which thebaia acts to the admirable researches of Claude Bernard. This distinguished physiologist has further demonstrated that thebaia does not possess any soporific property, that it is the most active toxic principle in opium, and that it ranks first among the alkaloids of this drug that have a convulsant action[1]. From our experience of its properties we should assign to it a lower rank than brucia as a toxic and convulsant substance.

Iodide of methyl-thebaium is more soluble in hot water and in dilute spirit than the iodides of methyl-strychnium and methyl-brucium, and, on this account, we commenced its administration in relatively small quantities. We found that doses of one, five, and six grains, nearly completely dissolved in very dilute spirit, and administered to rabbits by subcutaneous injection,

[1] *Comptes Rendus*, 1864, p. 413.

produced absolutely no effect. When, however, the dose was increased to ten grains, partial and then complete paralysis was caused, and death occurred eleven minutes after the administration. The effects were, in all respects, the same as those observed with the methyl derivatives of strychnia and brucia; there was, therefore, a complete absence of any convulsive symptoms and of exaggeration of reflex activity, and the *post mortem* phenomena were those that follow curare-poisoning. In another experiment, eight grains was injected under the skin of a rabbit weighing two pounds and three quarters: this produced general paralysis and complete muscular flaccidity, but it was ultimately recovered from. For the purpose of testing the poisonous activity of the thebaia itself, one-fifth of a grain was injected under the skin of the same rabbit: convulsive starts and spasms, great exaggeration of reflex activity, and violent attacks of tetanus were quickly produced, and soon terminated in death. *Post mortem* rigidity, with an acid reaction of the muscles, occurred in less than forty minutes afterwards, and while the temperature of the body was as high as 95° F. About 5·5 grains of the alkaloid thebaia are contained in eight grains of iodide of methyl-thebaium; the poisonous activity of thebaia is, therefore, reduced at least thirty times by the addition of iodide of methyl.

Without describing the experiments in which this substance was exhibited by internal administration, nor those in which the sulphate was employed, it is sufficient to observe that we have obtained the most satisfactory proof of a complete change having been produced in the physiological action of thebaia by chemical addition. This change is the same as that which occurs with strychnia and with brucia.

Codeia.

We have examined the effect of the addition of iodide and sulphate of methyl to codeia—an opium alkaloid which is the second in toxic activity, and which possesses distinct convulsant, but feeble soporific, properties.

Iodide of methyl-codeium.—Five grains of iodide of methyl-codeium can be readily dissolved in a sufficiently small quantity

of warm water to allow of its injection into the subcutaneous tissue of a rabbit; but no effect was produced by this dose. Serious and prolonged symptoms were caused by the administration, in the same way, of fifteen grains; but even this large quantity did not induce a fatal termination. The rabbit to which this had been given was quickly affected with convulsions and opisthotonos after the subcutaneous administration of one grain of codeia; and this proved a fatal dose.

As much as thirty grains of iodide of methyl-codeium may be given to rabbits, by the stomach, without producing any apparent effect.

Sulphate of methyl-codeium seems to have precisely the same action as iodide, but the fatal dose of the sulphate is somewhat less than that of the iodide.

Neither iodide nor sulphate of methyl-codeium possess the slightest convulsant action. Experiments with frogs have shewn us that reflex exaggeration is never produced, but that, with comparatively large doses and after some time, paralysis of the motor nerve end-organs occurs. Codeia has but a feeble soporific action, and it is, therefore, difficult to determine if this is affected by chemical addition. We are at present inclined to believe that it is not.

MORPHIA.

The only other opium alkaloid in which the effects of chemical addition were examined is morphia. The most recent and trustworthy investigations shew that this substance is next in activity as a soporific to narceia, that it possesses a less convulsant action than codeia, and that its fatal dose is one of the largest of those of the active principles of opium[1].

Iodide of methyl-morphium.—As iodide of methyl-morphium is nearly insoluble in cold and but sparingly soluble in warm water, it was administered in the form of a fine powder suspended in water. We were unable to produce any effect whatever, even when so large a dose as twenty grains was injected under the skin of a small rabbit, and from the bulky character of the powder a larger quantity could not be conveniently

[1] Claude Bernard. *Op. cit.*

administered. Eight grains of morphia was afterwards exhibited, in the same way, to this rabbit. In about an hour, a tendency to sleep was observed, the eyelids closed and the head sank on the table, but a slight sound immediately roused the rabbit. In two hours, the soporific effect was more marked; and the animal remained in almost any position in which it could be placed, provided the change was made gradually and gently; and, however unnatural the position might seem to be, if it were consistent with rest, sleep immediately occurred. This condition lasted for about forty-eight hours, when spasms made their appearance, and, by and by, assumed all the characters of epileptiform convulsions. The rabbit was found dead on the morning of the third day after the administration. On one occasion twenty grains of iodide of methyl-morphium was introduced into the stomach of a rabbit, but even this large quantity was insufficient to produce any effect.

As we have completely failed in causing any symptom, in warm-blooded animals, with this preparation, we have no data by which to determine how far the poisonous activity of the morphia that it contains has been reduced.

Any conclusions drawn from experiments made on such animals as rabbits, with a substance whose predominating action is a soporific one, are always liable to objection. For this reason we were induced to try the effect of iodide of methyl-morphium on man. One of us[1], who is perfectly susceptible to the action of morphia, took, on one occasion, half-a-grain of iodide of methyl-morphium in the form of powder; but this produced no effect. On another occasion, one grain was taken also as a powder; but not the slightest soporific or other action was caused. The latter dose contained about three-fourths of a grain of morphia, and this is certainly much above the usual narcotic dose of this substance.

Sulphate of methyl-morphium is, in common with the other sulphates we are occupied with in this paper, an extremely soluble compound. Ten grains, administered in solution by subcutaneous injection, produced paralysis, well-marked narcosis, and death, in a rabbit. Eight grains was not a fatal dose, but it

[1] Dr Fraser.

caused complete paralysis with long-continued narcosis. Neither in these, nor in any of the many other experiments we performed with this substance, was there any trace of spasmodic action or of exaggeration of the reflex function. The predominating symptoms were those of paralysis, but it was somewhat difficult to judge how much of this was due to the co-existing narcotism.

To determine this, the blood-vessels were tied in one limb near the knee of each of two frogs, selected because of their resemblance to each other in weight and in activity. One grain of sulphate of methyl-morphium in solution was injected into the abdominal cavity of one of these frogs, and three-fourths of a grain of morphia, dissolved in very dilute sulphuric acid, into the abdominal cavity of the other. The frog with sulphate of morphia was affected, in about an hour, with clonic spasms and exaggeration of reflex activity; in two hours, with several distinct attacks of tetanus; and it was found dead and in *rigor* on the following morning. The frog with sulphate of methyl-morphium was flaccid and paralysed in twenty minutes; and, in thirty minutes, galvanic stimulation of any portion of the skin was followed by energetic movements of the *tied limb*, but of no other part. The further phenomena proved that the peripheral terminations of the motor nerves were paralysed.

Iodide of methyl-morphium produces the same effects on frogs as sulphate, only a larger dose is required.

When administered by the stomach the same quantity of sulphate as of iodide of methyl-morphium—twenty grains—has been found insufficient to affect a rabbit. It has, however, been ascertained that soporific effects may be produced in man by sulphate of methyl-morphium.

NICOTIA.

The last substance in which we have now to describe the modifications produced by chemical addition is nicotia. This is a liquid alkaloid of great energy, derived from tobacco.

Iodide of methyl-nicotium is a crystalline body readily soluble in cold water. A dose of five grains, exhibited by subcutaneous injection, produced no effect on a rabbit. Ten grains

caused trembling and slight impairment of motility; and the same symptoms occurred, in a somewhat exaggerated form, after the administration of fifteen grains: but recovery took place after both doses. The subcutaneous injection of twenty grains was followed, after several hours, by death; no convulsive movements having occurred during the progress of the symptoms. An experiment was made with a very small dose of the nicotia with some of which this iodide of methyl-nicotium had been prepared, and it was found to have the usual energetic properties of the alkaloid. As about eight grains of nicotia are contained in fifteen grains of iodide of methyl-nicotium, and as one-tenth of a grain of nicotia is a fatal dose for a rabbit, while fifteen grains of iodide of methyl-nicotium is less than a fatal dose; it follows, that the addition of iodide of methyl renders nicotia at least eighty times less powerful as a poison.

On account of the readiness with which iodide of methyl-nicotium dissolves in water, it was not to be expected that any change of poisonous activity would be caused by its conversion into a sulphate; and our experiments have shewn us that the fatal dose of sulphate of methyl-nicotium is nearly the same as that of iodide of methyl-nicotium.

In the absence of any very trustworthy investigation into the mode in which nicotia acts, we cannot ascertain exactly how far its physiological properties are modified by chemical addition. It would appear, however, that the convulsive movements, which always occur during nicotia-poisoning, are not among the symptoms produced by either iodide or sulphate of methyl-nicotium. We have also found that this modification is not due to an action of the changed substance on the motor nerves; for it has been ascertained that paralysis of neither the trunks nor end-organs of these nerves exists after the action of iodide or sulphate of methyl-nicotium.

Some experiments were made to determine the physiological effects of iodide of methyl. The only bearing of these on the present investigation is, that no evidence was obtained in support of the extremely improbable hypothesis, that some of the changes produced in the action of the substances we

have described might have been due to addition of the physiological action of the methyl-compounds.

We have thus shewn that chemical addition produces some important modifications in the action of those poisons which have been treated of in this communication. The action of strychnia, brucia, thebaia, codeia, morphia, and nicotia, is evidently greatly diminished in degree and, at the same time, completely changed in character. The latter effect is strikingly and remarkably illustrated by the complete change that is produced in the action of strychnia, brucia, and thebaia; it is apparent in codeia and morphia; and it is least obvious in the case of nicotia. We may conclude from these facts that when a nitrile base possesses a strychnia-like action, the salts of the corresponding ammonium bases have an action identical with that of curare.

It is well known that curare and strychnia are derived from plants belonging to the same *genus*, and it is, therefore, interesting to observe such a relationship. It may not, however, be superfluous to add that strychnia, brucia, and the other spinal stimulant alkaloids examined in this paper, have not been converted by chemical addition into curarina—the active principle of curare. The actions of the methyl derivatives of these bases are of precisely the same character as that of curare, and they possess the same peculiarity of slow absorption by the mucous membrane of the digestive system; but the degrees of their activity are very different. If we confine our attention to the salts of the methyl derivatives of strychnia, brucia, and thebaia, where the action is uncomplicated, we observe that they form a series in which the fatal dose varies for each, while this dose in the case of the most active of the three is considerably above that of curare, and greatly above that of curarina. Besides, curarina has a characteristic colour reaction that belongs to none of these bodies; and the latter further prove their dissimilarity by each of them possessing special colour reactions by which they may be distinguished from each other.

It is not only of great interest, but probably of some practical value, that five new compounds should be found

having the physiological action of curare. The great difficulty of obtaining this substance has hitherto proved a serious barrier to its therapeutical employment. Although none of the compounds that we have shewn to act as curare does, are so energetic as that substance, three of them—sulphate of methyl-strychnium, of methyl-brucium, and of methyl-thebaium—are sufficiently so to rank as powerful poisons, and to fulfil all possible therapeutical requirements. Moreover, they may be readily obtained in a state of perfect purity, and therefore of constant strength; and, in this respect, they possess a great advantage over curare. For all purposes of physiological study and demonstration, they may also be substituted, with advantage, for this poison.

There is another result of this investigation, from which, without being considered over-sanguine, we may anticipate an important practical advantage. The action of morphia is not a simple one. In addition to its chief action as a soporific, it exerts a stimulant effect on the spinal cord. The latter sometimes manifests itself in human adults, it frequently does so when large doses of morphia are administered to children, and it invariably appears in the lower animals as a symptom of nearly equal prominence with narcosis. The soluble salts of methyl-morphium have been shewn to possess a narcotic but no spinal stimulant action. It is therefore hoped that, in certain cases, they will prove advantageous substitutes for the salts of morphia; but the data we have as yet obtained on this question are insufficient to warrant any positive statement.

It is curious, though not unexpected, that the ordinary colour reactions of the alkaloids are retained by their methyl derivatives. This may possibly prove of some importance to the medical jurist; and as these compounds are not precipitated by alkalies nor by the carbonates of the alkalies, some difficulty may be met with in discovering their presence in cases of poisoning.

This investigation has done little more than merely introduce us into a vast field of inquiry, but it has justified us in expecting that important fruits may be obtained by further and careful cultivation.

ON A CASE OF CONGENITAL MALFORMATION OF THE FALLOPIAN TUBES, &c. By T. GRAINGER STEWART, M.D., F.R.S.E., *Pathologist and Extra Physician to the Royal Infirmary; Physician to the Royal Hospital for Sick Children; Lecturer on General Pathology, Surgeons' Hall, Edinburgh.*

IN a patient who died of typhoid fever about the middle of May, 1867, certain peculiar morbid conditions of the pelvic viscera were found. The following description of the case is extracted from the Pathological Register of the Royal Infirmary.

The *pelvis* was of natural size and form. The *bladder, vagina,* and *rectum,* were natural. The *uterus* was of natural size. The lower half of the cervix was inclined backwards and to the left; but in the middle there was a sudden bend, so that the upper half of the cervix and the whole of the body of the organ was at an obtuse angle to the lower part, and was so far inclined towards the right, that the fundus was considerably out of the middle line. The *cavity* contained some reddish mucus. The *walls* were natural. The *right Fallopian tube* was connected with the uterus in the usual way, and it presented a natural appearance for one inch and a quarter from its commencement, but there it terminated abruptly in a cul de sac, and a fibrous band of the same length as the tube stretched across the space and connected it with the anterior wall of the rectum. The *left tube* was also natural at its commencement; it extended along for three inches; in the first two it gradually expanded until, on being laid open, it measured half an inch; from that point it gradually narrowed, and terminated in a cul de sac, without trace of fimbriæ, but with a number of small cysts mostly on slender stalks, which appeared to correspond to fimbriæ. Its outer third was connected by a firm but slender fibrous membrane with the peritoneum covering the rectum. Both tubes contained a reddish watery fluid. The *left ovary* was of natural size; on its surface there were numerous cica-

trices, both old and recent. It occupied its natural position, but was partially concealed by fibrous adhesions. The *right ovary* was also natural in structure, but it was more completely concealed by adhesions, and by a group of cysts. On section both were found to contain corpora lutea and Grafian vesicles. The *cysts* just mentioned were situated to the right of the ovary, and somewhat behind it, quite unconnected with it, but so closely connected with the *body of Rosenmüller* that it was evident that they had been formed by dilatation of some of its tubes. Together they formed a mass of the size of a walnut. The *body of Rosenmüller* of the left side was natural. On the right side there was a single group of small cysts on long pedicles (Hydatids of Morgagni). There were numerous adhesions between its different peritoneal surfaces, besides the two denser bands connecting the tubes with the rectum. The most prominent were some which connected the fundus uteri with the larger group of cysts, and some which deepened and narrowed Douglas's space.

In this case it appears to me we have a congenital malformation of the Fallopian tubes and a morbid development, in connection with the parovarium, as the original morbid conditions, while the numerous bands of adhesions were results of the irritation of the ova which escaped from the ovaries, and to them again the peculiar malposition of the uterus is referable. In this view my friend and colleague, Dr Matthews Duncan, concurs. The patient was a married woman, but was childless.

The only points which call for remark are the Fallopian tubes and the position of the uterus.

I. The *Fallopian tubes*.

Klob mentions, in his excellent work on the morbid anatomy of the female generative organs[1], that the congenital deficiencies of the tubes may be reduced to three classes:

(*a*) Those in which the tubes are purely rudimentary, represented either by traces of fibrous tissue or by bands of muscular substance.

(*β*) Those in which they are represented by a solid cord of fibrous tissue.

[1] *Pathologische Anatomie der weiblichen sexual organe.* Wien, 1864.

(γ) Those in which the development of the fimbriæ about the extremity is defective.

It is evident that our case cannot be exactly referred to any of these classes; and, so far as I am aware, it would appear to constitute a new variety of malformation.

II. The peculiar flexion of the uterus.

Flexion more commonly occurs at the upper part of the cervix than at the middle as in our case. Klob remarks[1] that in congenital lateral flexions the position of the cervical portion remains natural, while in the acquired it is inclined in a direction opposite to that of the body of the organ. Our case confirms this statement and shews that the same is true in cases where the flexion is in the cervix, rather than between the cervix and the body of the organ.

ON A SUPERNUMERARY OBLIQUE MUSCLE OF THE EYEBALL. By THOS. STRANGEWAYS, *Professor of Veterinary Anatomy, Edinburgh.*

A FEW days ago, when dissecting the muscles of the eyeball of an ass, in the dissecting-room of the Veterinary College, I was somewhat astonished at finding a small but well-defined muscle situated between the superior and inferior oblique muscles. It originated by a delicate tendon from a minute depression, in the superior part of the orbital plate of the frontal bone, about midway between the origin of the inferior oblique and the loop or pulley through which the belly of the superior oblique passes. The tendon of origin was succeeded by a fusiform fleshy belly of about three lines in diameter and about an inch in length, which passed obliquely upwards and outwards on the outer side of the external rectus. The belly, embedded in a quantity of adipose tissue, terminated in a thin, flat tendon, which, after running nearly parallel for a short distance with, and loosely attached by cellular tissue to, the upper part of the

[1] *Op. cit.* p. 71.

belly of the superior oblique, became blended with the tendon of insertion of that muscle just as it passed under the tendon of insertion of the superior rectus.

As there are some slight differences between the arrangements of the oblique muscles of the eyeball of the Equinæ and those of Man it may be necessary to point these out, so as to prevent any misunderstanding as to the position of this small oblique muscle.

The superior oblique muscle in the horse and ass is, 1st, relatively longer and larger than in man, and is fleshy for some distance after it has passed through the loop, which loop is situated at the base of the orbital process of the frontal bone. 2ndly, the muscle, after passing through the loop, extends almost directly outwards under the tendon of the superior rectus to gain its insertion between the tendons of insertion of the superior and external recti. The point of insertion is thus not so far to the back of the eyeball as in man.

The inferior oblique, arising from the lachrymal fossa, is directed forwards and outwards, its belly running in the same direction as the reflected portion of the superior oblique, and becomes finally inserted between the tendons of insertion of the external and inferior recti, much lower down and also further forwards than in man.

So far as my researches have gone this small muscle has not hitherto been described, either in consequence of being an exceptional occurrence in this animal or of having been overlooked. There can be no doubt I think of its being an accessory or check muscle of the superior oblique, placed there for the purpose of preventing the belly of that muscle becoming fixed in the loop through which it has to pass at such an acute angle, in the lower animals more especially.

Unfortunately the other eyeball had been removed by one of the students, to whom the subject belonged, before I had commenced my dissections; but still, on searching within the orbit, I was enabled to find part of the belly and the tendon of origin of a similar muscle, which had precisely the same point of origin and, in all probability, a similar insertion.

AN ACCOUNT OF AN ENORMOUS TUMOUR, PRESENTING THE TYPE OF STRUCTURE OF THE CHORDA DORSALIS. By PROFESSOR TURNER. (Read before the Royal Medical Society, March 27th, 1868.)

A FEW weeks ago a tumour, remarkable not only for its size but for its structural characters, was presented to the Anatomical Museum of the University of Edinburgh, by Dr Thos. Dobson of Windermere, by whom it was removed after death from the body of a man aged 54. To Dr Dobson I am indebted for the following account of its growth and connections.

History.—"Prior to a fall in the year 1861, in which the man was considerably bruised in the lumbar region, he had enjoyed excellent health. A few months after the fall he began to walk lame, and complained of pain in the muscles in front of the left thigh. As time went on these symptoms increased, and, in 1865, I detected a tumour, about the size of a hen's egg, hard, firm, immoveable, with a slightly irregular surface, situated deeply in the left hypogastric region, and apparently springing from the sacro-iliac synchondrosis. It neither pulsated nor was influenced by the state of the bowels. As it steadily increased in size œdema of the left lower limb came on, and the pain increased in severity. He now consulted the surgeons to the Liverpool Infirmary, who pronounced the tumour to be an osteo-sarcoma, and he afterwards became a patient both of the Charing-Cross and Middlesex Hospitals. The tumour gradually extended upwards, displacing the six lower left ribs upwards and outwards, extending into the right inguinal region, and, by pressure on the veins, occasioned œdema of the right thigh, and the abdominal walls were so thinned that the irregular surface of the tumour was visible to the eye. He died on the 24th of February worn out by pain and bedsores. It is remarkable that during the whole illness the functions of the bowels and bladder were but little interfered with.

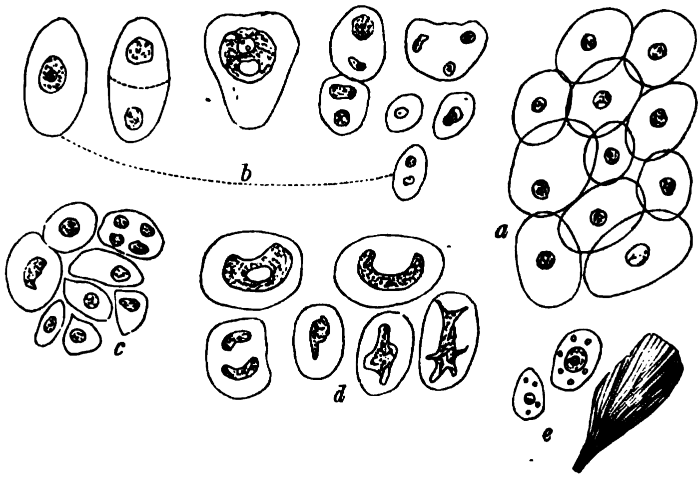
"*Post mortem* made 20 hours after death, the body was seen to be much emaciated, the lower limbs, scrotum, and penis immensely swollen; the girth at the umbilicus was 50 inches. When the abdomen was opened the tumour was seen to occupy the whole cavity, except the right hypochondrium and a small portion of the right lumbar region, which contained the stomach, ascending and transverse parts of the colon and small intestines in front and the liver behind. On the right side it reached as high as the margin of the lower ribs; on the left as high as the fifth costal cartilage: laterally it overlapped the left iliac crest, and below it descended into the pelvis and pushed the bladder towards the floor; posteriorly it was in relation to the sacrum, lumbar, and dorsal vertebræ, the last dorsal and two upper lumbar being hollowed out by pressure. The aorta and vena cava were pushed over to the right. The left kidney small and displaced upwards, the right normal both in size and position. Liver fatty, spleen small. Heart displaced to right of sternum. Descending colon passed through a groove in the tumour on its posterior and left surface. The adhesions of the tumour were extensive, and its removal from the dead body, even with the portions of lumbar spine and left ilium, from which it grew, was no easy matter. The weight of the tumour and connected bones was 46 lbs., the probable weight of the tumour alone 44 lbs."

General characters.—The tumour was sent me immediately on its removal, and presented the following appearance. Irregularly and broadly ovoid in form, the narrower end being directed upwards, whilst the broader end was connected with the left innominate bone. The acetabulum appeared immediately below the lower border of the tumour, whilst the sacrum and lower lumbar vertebræ projected from its right posterior aspect. Its longitudinal circumference was 3 ft. 6 in., its greatest transverse circumference 3 ft. 5 in. It was deeply and irregularly lobed, and its anterior and right lateral surfaces were invested by the somewhat thickened peritoneum, beneath which small vessels injected with blood could be readily seen. A well-marked fibrous capsule invested the tumour, not only where the serous covering was deficient, but beneath

that membrane also. When bisected in the mesial plane of its long axis the surface of section, which measured 18 in. by 16 in., presented the following appearance. Each of the large irregular lobes was subdivided into numerous lobules, varying in size from a pea to a walnut, which were invested by thin capsules of connective tissue continuous with the general fibrous capsule of the entire tumour. Some of the lobules had a pearly lustre and a fine, compact, and almost cartilaginous consistence; others, again, had a pinkish, yellowish, or faint greenish colour, and these had a consistency more like that of stiff jelly, and could be enucleated from their capsules with great ease. Though the tumour was firm, and the lobules generally were compact, yet it had none of the toughness of a fibrous tumour, and could without difficulty be broken down by the fingers. It was succulent, and a yellowish non-creamy fluid, in which minute oil-drops floated, drained away. When the tumour was bisected several cysts were opened into; of which one was large enough to contain a fœtal head, and from their interior a turbid yellowish fluid escaped. A smooth semi-opaque membrane partially lined these cysts, but in part irregular, villous masses projected from the inner wall into the cavity, traversing it much in the same manner as the bands one sees passing across a large vomica in a tuberculous lung. The sacrum and lower lumbar vertebræ, which had been removed along with the tumour, and at first sight seemed to be incorporated with it, could be dissected away without injury. But the left ilium and pubis were involved in the substance of the tumour, which seemed indeed, as Dr Dobson had surmised, when he first detected its presence, to have originated about the region of the left sacro-iliac joint. The ilium was expanded, its cancelli greatly enlarged, and filled with little masses, presenting the same appearance as those occurring in the body of the tumour itself. Portions of bone also lay in the interior of the tumour detached from the general substance of the ilium. In some parts calcareous formations had taken place, and numerous small nodules of white, hard, lime salts, which effervesced on the addition of an acid, were met with.

Microscopic characters.—Thin sections of the pearly white

lobules, examined under water with a magnifying power of 200 diam. were seen to be composed of exquisitely pellucid, round, oval, or somewhat flattened cells (*a*), which possessed a very delicate outline, and usually contained a single round, or oval nucleus, but with no trace of granular matter within the cells, or of intercellular substance between them. These cells closely resembled in form those of which the rod of embryonic cartilage, called chorda dorsalis, is composed, and, with some modifications to be next described, these simple cell forms made up the lobules of this enormous tumour. In those lobules, which had a yellow colour, whilst the fundamental type of structure was preserved, numerous fat granules, partly free,



Note of explanation to Figure. *a*. Cluster of cells from a pearly white lobule. *b*. Various forms of nuclear subdivision and cell multiplication. *c*. Group of young cells from one of the cancelli. *d*. Cells with irregular forms of nuclei. *e*. cells with fat granules and a peculiar mass of acicular crystals.

partly within the cells (*e*), partly within the nuclei, were seen, and this fatty character was especially visible in those yellow lobules which lay next the inner walls of cysts, and evidently pointed to a degeneration of the cells and lobules, preceding probably the cyst formation. In some localities peculiar striated bodies (*e*), apparently composed of a crystallized fatty acid, were visible. Various slices from portions of the tumour, infiltrated

into the cancelli of the bone, were examined, and in them the cells were for the most part much smaller than in the pearly lobules, and collected into groups (*c*). Several nuclei also were often seen in a single cell, and not unfrequently they exhibited elongations and constrictions as if in the process of dividing. But this polynucleated form of cell was found also in many other parts of the tumour (*b*), which made it probable that there the development of new cells was actively going on and the consequent growth of the tumour most active. The same pellucid, non-granular character of the cells was observed in the tumour masses within the cancelli as in the pearly white lobules. In many of these cells, as well as in other parts of the tumour, the nuclei were irregular in form, much elongated, club-shaped, crescentic, star-like, or even perforated (*d*). It is important to note that the tumour possessed comparatively slight vascularity, and such vessels as it contained were situated in the general fibrous capsule, or the prolongations which passed between the lobules, and not amidst the proper cell structure, which, like the cells of the chorda dorsalis, were extra-vascular. The larger lobules had, however, processes of connective tissue passing into their substance from their investing capsules, which were in many cases so delicate as to be only recognised by the microscope, and which served to subdivide their constituent cells into still smaller groups.

Classification.—This tumour in its intimate structure is undoubtedly cellular, and the cells, for the most part, possess that appearance which is so characteristic of the cells of the chorda dorsalis. If we accept therefore an anatomical classification of tumours, based on their resemblance to normal structure, it should be referred to a group of tumours having for its type the cells of the rod of embryonic cartilage, around which the bodies of the vertebræ and the basi-cranial axis are developed. But if in its minute structure the tumour is capable of being referred to the chorda, it can have had no genetic relation with it, for, though in close proximity to the spine, yet it did not spring from the vertebræ or their intervening discs, but rather seemed to arise either in the ilium or from the region of the sacro-iliac joint. Hence we must look to

these localities for the structures, from the morbid changes in which the tumour took its origin. There is, I think, reason to believe that it had originated within the ilium, probably in close proximity to its sacral articulation, and from the expanded condition of so many of the cancelli of this bone and the presence of tumour substance within them, the morbid changes leading to the production of the diseased mass, were obviously still in operation at the time of death. The medullary tissue of the ilium contains round or oval polynucleated cells, which Kölliker, many years ago, described, and named "marrow-cells," and distinguished from the ordinary oil-containing cells of the marrow. Now, it is quite conceivable that the morbid process may have commenced in connection with these marrow cells, and that by an exuberant proliferation of the nuclei, and consequent abnormal cell multiplication, the tumour may have owed its beginning. But it is clear, from an inspection of the tumour itself, that its subsequent rapid growth was largely due to a multiplication of its own proper cells by nuclear subdivision.

In many of its general characters indeed this tumour closely resembled the group to which Mr Paget has applied the name of Myeloid, and in the presence also of a proportion of cells, containing many nuclei, its microscopic structure in so far accords with the character, which he lays down as essential to the group, but nowhere did I recognise any of the elongated "fibro-plastic" cells, which so frequently constitute anatomical elements in the myeloid tumour. Should this tumour have originated from morbid changes in the marrow-cells of the ilium, then there would be an additional reason for associating it with this group. And it may, indeed, be a question for consideration whether the term myeloid should not be reserved for those tumours which take their rise in and from the medullary tissue of bone, and in their structure are chiefly composed of large, round, or oval cells, even though the polynucleated condition should exist only in a small proportion of the cell-structures of the tumour. For the presence of several nuclei in a cell is rather an indication of a particular stage in the growth or development of that individual cell, than an evidence of a specific character.

ON THE FORM OF THE CRANIUM AMONG THE PATAGONIANS AND FUEGIANS, WITH SOME REMARKS UPON AMERICAN CRANIA IN GENERAL. By PROFESSOR HUXLEY, LL.D., F.R.S.

Fig. 1.

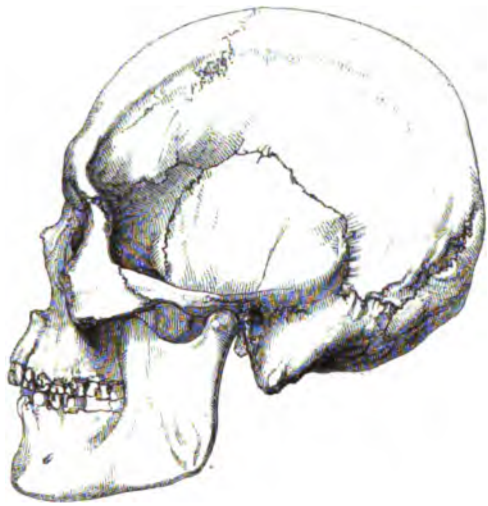


Fig. 3.

Figs. 1 and 3. Lateral and upper views of the skull of a Patagonian.

Fig. 2.

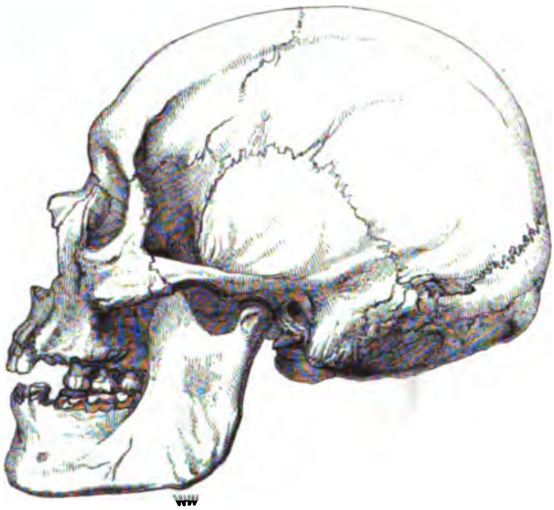


Fig. 4.

Figs. 2 and 4. Lateral and upper views of the skull of a Fuegian.

Fig. 5.

Fig. 7.

Figs. 5 and 7. Facial and occipital views of the skull of a Patagonian.

Fig. 6.

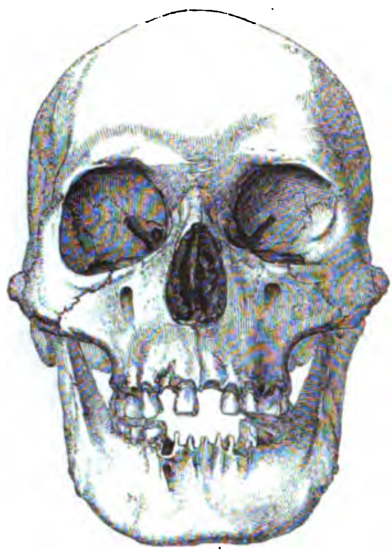


Fig. 8.

Figs. 6 and 8. The same views of the skull of a Fuegian.

Dr Morton, the well-known author of the *Crania Americana*, repeatedly expressed, and throughout his life adhered to, the opinion, that all the people of the two Americas, excepting the Esquimaux, have essentially one physical conformation, and

belong to one and the same stock. Thus in the posthumous papers published by Messrs. Nott and Gliddon, (*Types of Mankind*, 1854, p. 324), he writes:

"... The physical character of the American races from Cape Horn to Canada is essentially the same. There is no small variety of complexion and stature; but *the general form of the skull*, the contour and expression of the face, and the colour and texture of the hair, together with the mental and moral characteristics, all point to a common standard which isolates these people from the rest of mankind"

And at p. 325:

"Every one who has paid attention to the subject is aware that the Peruvian skull is of a rounded form, with a flattened and nearly vertical occiput. It is also marked by an elevated vertex, great interparietal diameter, ponderous structure, salient nose and broad prognathous maxillary region. This is the type of cranial conformation to which all the tribes from Cape Horn to Canada more or less approximate."

However, Dr Morton somewhat qualifies this expression in the succeeding paragraph:

"I admit that there are exceptions to this rule, some of which I long ago pointed out in the *Crania Americana*, and others have been recently noticed among the Brazilian Tribes by Professor Retzius."—

This passage was written about 1851. But those who read what follows will hardly allow that it gives an adequate notion of the bearing of Retzius' labours upon American Ethnology, and especially upon Dr Morton's conclusions. At this time Retzius had, in fact, demonstrated beyond all question the total inaccuracy of these conclusions, so far as the form of the cranium is concerned, by a series of researches, the results of which, published at intervals from 1844 to 1856, appear in the following notices:

I. *Ueber die Form des Knochengerüstes des Kopfes bei verschiedenen Völkern*. Published in 1844. (Retzius' *Ethnologische Schriften*, pp. 27—40).

In speaking of America, Retzius remarks, p. 37:

"In no other part of the world does the shape of the skull show so many definite differences, in none more and greater extremes, and nowhere are the different nations so interspersed among one

another. Thus, a few years ago, I received from Professor S. Lovèn the skull of a South Patagonian, which is remarkable for its length, depression and lateral compression. According to the account received this is the predominant form in southern Magalhaen's land, though, on the contrary, the nearest neighbours of this people, the Pampeans or Puelches, have short, broad and higher skulls."

On the following page, Retzius gives a table in which he classifies the Americans as follows:

Gentes dolichocephalæ prognathæ.

Americæ septentrionalis.
Greenlanders and Esquimaux. Koluschea.
Cherokees. Chippeways. Iroquois. Hurons.
Chickesaws. Cayugas. Ottigamies.
Pottowattomies. Lennilenape. Blackfeet.

Americæ meridionalis.
Botocudos. Caribs. Guaranis. Aymaras.
Huanchas. South Patagonians.

Gentes brachycephalæ prognathæ.

Americæ septentrionalis.
Natchez. Creeks. Seminoles. Euchees.
Klatstonis.

Americæ meridionalis.
Charruas. Puelches. Araucanians.
Modern Peruvians.

And he adds as doubtful, *Brachycephalæ orthognathæ*, the Aztecs in Mexico, and the Chincas in Peru.

II. *Beurtheilung der Phrenologie von Anatomisch-Ethnologischen Standpunkte aus.* Published in 1847. (Retzius, *Ethnologische Schriften*, pp. 70—85.)

"Among the *American* races of mankind both dolichocephalic and brachycephalic tribes occur.—Nowhere are such extreme forms to be met with as in the new world, many tribes producing them artificially. The greater part of the Canadian Indians are, so far as I know, dolichocephalic. In the United States both forms occur in different territories...... The Mexican Indians are, for the most part, brachycephalic. Many flatten the skull from behind forwards, whereby it often attains an unnatural shortness and height......

"In Venezuela, Guiana, Brazil, Paraguay, and the neighbouring states, the dolichocephalic form again predominates. To this belong the Caribs, Botocudos, Guaranis, &c.......

"In Peru, the Incas, immigrants from Mexico, with especially short and flattened occiputs, are found, besides the Chincas or Yungas, whom Tschudi reckons among the aborigines of the country. According to the same author, there are dolichocephalic tribes, namely the Huanchas and the Aymaras, in Peru......

"The Indians in all the rest of South America, namely the Araucanians in Chili, the Charruas, Puelches, &c. in Uruguay, the La Plata States and Magelhaen's land[1] are, so far as I can discover, all brachycephalic."

III. *Ueber die Schädel-form der Peruaner.* Published in 1848. (Retzius, *Ethnologische Schriften*, p. 94).

In this paper Retzius first describes five mummified skulls, which he considers to belong to the Incas, from a tumulus near Pisco, on the coast south of Lima in 13° 46′ S, and 76° 9′ W. All were short, with flat, steeply-inclined, occiputs. The one figured has the cephalic index 0·91.

Three skulls sent from Lima, two of which belonged to complete mummies, on the other hand, are dolichocephalic, that figured having an index of 0·76.

In conclusion, Retzius remarks, p. 98:

"In brief, the American peoples in general may, like the nations of the old world, be divided into two principal groups, into brachycephali and dolichocephali. To unite these forms under one group, as was formerly done with the Slavonians and Germans, for example, on grounds of philological affinity, is to stray beyond the region of safe natural history fact. Just as in the old world, the people belonging to these two classes, seem, in many localities, to have lived in small societies scattered among one another; while, in others, they were more sharply separated into larger and usually inimical nations, of which sometimes the one and sometimes the other had the upper hand.

"I have, indeed, received a very long and depressed skull of peculiar form, said to come from Magelhaen's land; but for the present I hold its origin to be uncertain. Subsequently I have learned from Fitzroy and Darwin's Voyage that even the inhabitants of Tierra del Fuego present the same brachycephalic form as the other Puelches, whence I conclude that this form predominates in the whole southern part of South America.

The brachycephalic tribes in America form an almost uninterrupted series through the whole western side of this part of the world as far as Cape Horn."......

[1] This ascription of general brachycephaly to the people of Magelhaen's land is inconsistent with the opinion expressed in the preceding paper. See the third extract.

IV. *Bemerkungen ueber Schädel von Guarani-Indianern aus Brasilien.* Published in 1849. (Retzius, *Ethnologische Schriften*, pp. 112—117).

In this memoir the author describes five skulls of "Tapuios" (Tupayas), the mean cephalic index of which is 0·70. He mentions two others of quite the same form, and remarks (p. 116), that he has examined a number of Guarani and Carib skulls, and has never seen a round one. On the contrary, they are all elongated with a very projecting occiput.

Retzius remarks that the D'Orbigny's "Race Brasilio-Guaranienne," to which the "Tapuios," Guaranis and Caribs belong, extends from Guiana to Paraguay, and from the Antilles to the foot of the Bolivian Andes; and he suggests that the Aymaras, whom he regards as the primitive inhabitants of Peru, are of the same stock, laying some stress upon the resemblance between "Aymara" and the name "Aymores," which certain Botocudos give themselves.

V. In the letter to Dr Nicolucci (1852), (*Ethnologische Schriften*, pp. 120—124), Retzius writes:

"*En Amérique:* Toutes les races de ce continent peuvent être divisées en ces deux mêmes classes, savoir, en brachycéphales et dolichocéphales.

"*Les dolichocéphales* sont dominantes dans la partie orientale, savoir: Les Esquimaux, tous les Américains rouges, les Caraibes dans la Guyane, les Guaraniens au Brésil et au Paraguay, et les petites tribes des Huanches, originaires de Brésil.

"*Les brachycéphales* sont prédominants dans la partie occidentale, savoir: Les Caribiens, les Oregoniens, la plupart des Mexicains, les Chincas au Pérou, les Araucaniens, les Pampéens, les Patagoniens et les Fuegiens."

VI. *Ueber den Schädel eines Pampas Indianers.* Published in 1855. (Retzius, *Ethnologische Schriften*, pp. 131—135).

In this Essay Retzius describes the brachycephalic skull (the index of which is about 0·88) of a Puelche Indian from the Pampas south of Buenos Ayres. These Indians, he says, extend far south into Magalhaen's Land. The figure of the skull *l. c.* pl. VI. fig. 7) shews that the occiput has undergone a certain amount of artificial flattening.

At the end of this paper the following passage occurs:

"On a previous occasion I drew attention to the general distribution of the brachycephalic and dolichocephalic Indian tribes in America; the dolichocephalic predominating in the eastern, and the brachycephalic in the western parts of the immense American continent. Upon the eastern side we meet with dolichocephali in Labrador and in northern Canada, as Esquimaux; further south as numerous tribes of so-called Red Indians; formerly, in the West Indian islands as Caribs, and still as such in Guiana; as Guaranis, in Brazil and Paraguay. On the western side, the inhabitants of the Kurile islands, and probably of all Russian America; the Chenooks in Oregon, the Aztecs in Mexico, the Incas in Peru, the Araucanians in Chili, the Fuegians in Tierra del Fuego are brachycephalic. But in Magelhaen's land and in the Republic of Buenos Ayres all the Indian tribes are brachycephalic.

"On comparing the skulls of these opposed forms with those of other countries, it appears that the greater number of the eastern Indian tribes approach the Guanches of Teneriffe and the Atlantic people of Africa; the majority of the western Americans, on the contrary, rather resemble the Malayan and Mongolian stocks.

"This division, however, cannot be maintained with perfect strictness. Many tribes have spread in opposite directions, as the dolichocephalic Aymaras and Huanchas in Peru, who probably migrated from Brazil, and as the Creeks, Natchez, and many other brachycephali, eastward of the Rocky mountains, who probably came from Mexico and California."

VII. The views here expressed are further developed in the eminent Swedish Ethnologist's last and most complete memoir, entitled *Blick auf den gegenwartigen Standpunkt der Ethnologie mit Bezug auf die Gestalt des Knöchernen Schädelgerüstes,* published in 1856. (*Ethnologische Schriften,* pp. 136—162).

In this Essay the author shews that Morton's facts are wholly inconsistent with his hypothesis, that the Americans are of one physical conformation. "Hardly in any part of the world are there such contrasted dolichocephalic and brachycephalic forms as in America," is the conclusion which Retzius draws no less from Morton's observations than from his own. He repeats the conviction, at which he arrived in 1842 (and which is unquestionably correct), that the Greenlanders and Esquimaux are dolichocephalic, and very different from the Mongols; and he directs attention to the close resemblance

between the crania of the Esquimaux and of the Tunguses. Further, Retzius finds that the Chinese skulls very nearly approach those of the Tunguses and Greenlanders. In connexion with this subject he observes:

"According to this view, the stock to which the Esquimaux belong would only be Arctic in North America, but from its thinly inhabited area in the Islands of the Arctic Sea and the northernmost parts of America, it extends from west to east to China, of which it constitutes the proper Chinese population, which is to be carefully distinguished from the Tartar-Chinese."

Retzius had not seen an Aleutian skull, but he is disposed to regard the Aleutians as the connecting tribes of the Asiatic and American branches of this stock.

Repeating his views as to the relationship between the Guaranis and the Guanches, Retzius extends them so far as to include the Berbers and the Copts, and even the Jews, in the same category (*l.c.* p. 154), and seems not indisposed to call to his aid the old speculation touching the Atlantis to account for the wide distribution of this "Guarani-Hebrew" stock.

Retzius next proceeds to develope his already hinted hypothesis respecting the relation of the American brachycephali to the people of the South Sea islands and of Asia (*l.c.* p. 155), without adding much new matter. One passage however must be cited:

"I have seen no skulls of Indians from Tierra del Fuego, but I have examined the excellent profile portraits given in Capt. Fitzroy's 'Voyage.' From these portraits it is seen that the Indians of Tierra del Fuego, the Fuegians, are even more brachycephalic than the Pampeans." p. 158.

Nevertheless, on the chart appended to the *Ethnologische Schriften* there is a small red spot on the south coast of Tierra del Fuego, which should indicate the presence of dolichocephali in that region.

Professor Wilson, in his recently published work, *Prehistoric Man,* entirely confirms the general conclusions of Retzius, with whose writings, however, he does not appear to have been fully acquainted.

He gives measurements of 37 skulls of Western Canada Hurons, obtained from "graves to the north of the watershed between Georgian Bay and lakes Erie and Ontario," (Tab. IX. p. 468), of 10 Iroquois crania (Tab. X. p. 470), of 32 Canadian Algonquins (Tab. XI. p. 471), of 30 New England crania (Tab. XII. p. 473), and of 23 Algonquin Lenape crania (Tab. XIII. p. 476), of 22 "American brachycephali" (Tab. VII. p. 461), and of 31 "American dolichocephali" (Tab. VI. p. 460); making 185 crania of the uncivilized North American tribes in all. To these, Prof. Wilson adds (Tab. VIII. p. 464) the measurements of the heads of twelve living Algonquins. With two exceptions (Nos. 3 and 7) these last are brachycephalic, the average cephalic index of the whole twelve being 0·82–3, and I am at a loss to know why Prof. Wilson calls them dolichocephali (*l. c.* pp. 466 and 471), the cephalic indices which result from his own measurement of the longitudinal (L. D.) and parietal (P. D.) diameter being as follows:

No.	L.D. in.	P.D. in.	Index.
1	7·4	6·0	·81
2	7·1	6·0	·84
3	7·3	5·8	·79
4	7·5	6·1	·81
5	6·9	6·0	·86
6	7·1	6·0	·86
7	7·4	5·8	·78
8	7·2	5·9	·83
9	7·2	6·0	·83
10	7·3	5·9	·82
11	7·2	6·0	·83
12	7·4	6·6	·89

Similar errors have crept into his other tables. Thus, of his American dolichocephali, Nos. 2, 3, 5, 11 and 23 are brachycephali, and of the American brachycephali, Nos. 3, 4, 5, 6, 18, 21, 22 are dolichocephali. The Canada Algonquins are said at p. 471 to be all dolichocephali, but Nos. 1, 2, 3, 4, 5, 6, 17, 23, 25, 28 and 32 are brachycephali.

Revising Prof. Wilson's tables, I find that of the 197 crania referred to above, the measurements of which he gives, 145 are dolichocephali and 52 brachycephali. Almost all the skulls of the latter class are either Algonquin, Canada Algonquin, Algonquin Lenape, or belong to the following tribes, Muskagees, Dacotahs, Pawnees, Chetimachees, Chimayans, Osages, Creeks, Seminoles, Ottigamies, or Menominees. No Huron skull is brachycephalic, and only one Iroquois in ten, and that a female. Of the New England crania the same proportion, or only 3 in 30, are brachycephalic.

Prof. Wilson gives the measurements of 21 crania from ancient mounds and caves in the valley of the Mississippi. It does not appear that these have been subjected to artificial compression greater than that resulting from the use of the cradle-board, but they are all brachycephalic, and often eminently so, the average cephalic index being ·87.

So far as these observations extend, therefore, they tend to the conclusion that the ancient inhabitants of the valley of the Mississippi were brachycephali, and did not artifically flatten their skulls; a conclusion which is in harmony with the character of the heads represented in the terra-cotta works of that people. All the ancient Mexican and central American terra-cotta heads I have seen represent strongly flattened skulls.

That some of the ancient inhabitants of Mexico had naturally dolichocephalic skulls appears obvious from Prof. Wilson's Table IV. p. 458; but it is not so clear that any of them were naturally brachycephalic, as Prof. Wilson does not give any critical account of the materials whence his Table V. was drawn up, or figure any of the skulls. What he terms a "normal" skull of a Peruvian child, (*l. c.* p. 451, fig. 60), is as obviously distorted by circular compression as the adult skull, (*l.c.* fig. 59), which he also appears to consider to be normal, and I therefore hesitate to accept his Tables II. and III. of measurements of brachycephalic and dolichocephalic Peruvian crania as evidence.

Retzius, on the other hand, figures two Peruvian skulls (Pl. V. fig. 6, "Aymara," IV. fig. 5, "Inca Peruviana") one dolichocephalic and the other brachycephalic, neither of which has been affected, to any important degree, by pressure.

Prof. Wilson fully confirms Retzius' statements respecting the skulls of the Esquimaux and Greenlanders, and adds proof of the important fact that the Tchuktchi of Eastern Asia are similarly dolichocephalic.

In 1866 Dr Meigs, of Philadelphia, published a paper entitled, "*Observations upon the Cranial Forms of the American Aborigines*[1]," which acquires an especial importance from being based chiefly upon the study of Morton's collection. His most important conclusions in connexion with the subject of the present paper are the following:

"(1) That the crania of the aboriginal Americans are divisible into dolichocephalic, mesocephalic, and brachycephalic groups.

"(2) That the dolichocephali greatly preponderate in numbers over the mesocephali and brachycephali.

"(3) That, in the case of the Peruvian skulls in the Academy's collection, however, the short square heads are more numerous than the elongated forms.

"(4) That, in North America, neither the dolichocephalic nor brachycephalic tribes, when first known to Europeans, were restricted in their geographical distribution to any particular locality. While the former were scattered over the continent, through all degrees of latitude and longitude, the latter appear to have been, if we may judge from the specimens in the Museum, more numerous about the Great Lakes, at various places in the interior, in the south near the Gulf of Mexico, in the so-called Paduca area, and especially along the north-west coast. In general terms we may say that on the eastern or Atlantic side of the continent the dolichocephali appear to have prevailed, and on the western or Pacific side the brachycephali. This in a great measure seems to have been, and still is, the case in South America.

"(5) That long- and short-headed tribes, or races, are very commonly found throughout the two Americas side by side. In the extreme north, for example, dolichocephalic and brachycephalic forms are contrasted in the Esquimaux and their geographical neighbours the Konægi, or Kadiakian Aleutians, and again, in the far south, these diverse forms are exhibited in the Patagonians and Puelches.

"(6) That this contrast in cranial forms existed among the extinct races of America as it now does among extant tribes."

Dr Meigs, unfortunately, gives no numerical definition of what he means by dolichocephalic, mesocephalic, and brachy-

[1] *Proceedings of the Academy of Natural Science of Philadelphia*, May, 1866.

cephalic, but the general tenour of his observations is not the less clear for this uncertainty.

The extensive collection of American skulls which Dr Meigs studied, appears to have contained no original Patagonian or Fuegian skulls. Two casts are mentioned, one of the short and broad head of a Puelche girl, and the other of the long and cylindrical skull of a Patagonian. I suspect these must have been furnished by Retzius, in which case no dependence can be placed upon the authenticity of the second skull.

The great majority of the American skulls contained in the Museum of the Royal College of Surgeons have been artificially distorted. But in the following specimens distortion is either absent or slight in amount.

No. 5441.—The cranial part of a skull from the Saltpetre cave, Tennessee. Cephalic, index ·73.

No. 5441 A.—The skull of a Messisague or Mohawk Indian, from an old battle-ground at Rice Lake. Cephalic index ·73. The contour of this skull is, in many respects, like that of the Neanderthal fragment.

5441 B.—The skull of a Red Indian from Tennessee, figured by Mr Busk in the fifth volume of the *Natural History Review*. Cephalic index ·75.

5414 P.—The skull of the squaw of a Creek Indian, Upper Mississipi. Cephalic index ·74. This is an uncompressed prognathous skull with an elongated occiput.

5414 R.—The skull of a Chickasaw, Upper Mississipi. Cephalic index ·78. This skull may have undergone a slight compression at the upper part of the occiput. It is prognathous.

The most interesting of these dolichocephalic skulls, in relation to the subject of the present paper, however, is that of a native of Tierra del Fuego, presented by the late Captain Fitzroy, and thus described in the *Catalogue* by Prof. Owen:

"5428. The cranium is sub-elongate, moderately expanded at the parietal bosses, with a narrow and protuberant super-occipital; the forehead is narrow and low. The glabella is prominent and the nasals are produced. The malars are moderately prominent; the jaws prognathous; the chin well-developed. The base of the skull

presents paroccipital protuberances, large styliform processes of the sphenoid, and small but distinct Eustachian processes of the petronal. Traces of the maxillo-premaxillary suture remain on the palate. The molar teeth are of moderate size, and are worn on the inner border in the upper jaw and on the outer border in the lower jaw."

This cranium is represented in Figs. 2, 4, 6 and 8. Its cephalic index is ·74. It has not been distorted by pressure, and in its length, in the projection of the occiput, the width of the inter-zygomatic diameter (5·8 in.), the depth of the nasal depression, and the projection of the nasal bones, it presents no small resemblance to the skull of an Esquimaux.

Many of the other bones of the skeleton of this Fuegian are in the collection. The measurement of the principal bones of the limbs compared with the corresponding bones of an Esquimaux, are as follows:—

	Femur.	Tibia.	Sum of Femur and Tibia.	Humerus.	Radius.	Sum of Humerus and Radius.
Fuegian	16·6	13·8	30·4	11·85	9·5	21·35
Esquimaux	16·75	12·8	29·55	11·35	8·2	19·55

Thus the femora of the two are nearly equal; but the leg of the Fuegian is nearly an inch longer, owing to the greater length of the tibia. And the Fuegian's arm is nearly two inches longer, in consequence of the still more remarkable brevity of the radius in the Esquimaux.

However, it would appear that, in accordance with the statements of voyagers, the stature of the Fuegian was not very different from that of the Esquimaux.

When my friend Dr Cunningham, now naturalist on board H.M.S. Nassau, sailed for South America, I requested him to avail himself of any opportunity that might present itself for procuring Patagonian and Fuegian skulls. He has been good enough to bear my wish in mind, and not long ago I received a Fuegian and two Patagonian skulls which had been sent home by him, and which, in accordance with Dr Cunningham's desire, were placed at my disposal by the Hydrographer.

The cranium of the Fuegian was found "lying partially immersed in a pool of water" at Philip Bay, and is in a good

state of preservation, except that the nasal bones and the mandible are absent.

The cephalic index of this skull is ·78; so that it is broader than that figured. But as the last molar has not been cut, it is the skull of a young person, and many circumstances lead me to think it may be that of a woman.

It is a curious circumstance that in this skull, as in that in the College of Surgeons, there are very large and prominent "paroccipital processes," which, as the remains of the cartilage which tipped them shews, would have become considerably longer had the owner of the skull reached maturity. The face is distinctly prognathous.

The Museum of the College of Surgeons contains two undoubted Patagonian skulls, brought by the late Admiral Fitzroy from Port Melo on the east coast of Patagonia. They are described in the Catalogue as Male (No. 5426), and Female (No. 5427). The skull 5426 has the cephalic index ·87. It exhibits no more indications of occipital pressure than might arise from nursing. The skull 5427 is more flattened in the occipital region, and there are numerous Wormian bones in the lambdoidal suture. Its cephalic index is ·96; and (though I have no doubt that the skull was primitively broad) I am disposed to ascribe this excess of breadth over No. 5426 to artificial distortion arising from the use of the cradle-board. In fact, Fitzroy, in his *Narrative of the Surveying Voyages of H.M.S. Adventure and Beagle*, Vol. II. p. 154, says of the Patagonians:—

> "While infants are suckling, the mothers use frames or cradles in which their charges are carried about; they are made of flat pieces of wood, with a few semicircular guards of lath or thin branches, whose ends are fixed into holes in the wood. In such frames, between pieces of guanaco skin, the babies are placed; and while travelling these cradles are hung at the mother's saddle-bows."

For the opportunity of examining a third genuine Patagonian skull, I am indebted to Higford Burr, Esq., to whom it was intrusted by Captain Watson. It was found in a tumulus near the river Chupa, in latitude 43° S., longitude 67° W.

This skull is represented in Figs. 1, 3, 5 and 7.

The occiput is slightly flattened, especially on the right side,

but the distortion is not greater than might be produced by nursing. The cephalic index is ·89.

Of the two skulls sent from Patagonia by Dr Cunningham, one was found "sticking out of a sand-bank in Gregory Bay;" the other was procured in the course of "digging a hole for a flagstaff in the neighbourhood of direction Hills." The latter skull is, unfortunately, very fragmentary, and appears to have undergone *post mortem* distortion. But the former is nearly perfect, though it wants the lower jaw.

This skull (which is that of an adult male) shews very distinct evidence of artificial distortion. Not only is the occiput much flattened and unsymmetrical, but the very retreating forehead has such a surface as appears to me could only have been produced by the application of a frontal compress or bandage. Under these circumstances, the cephalic index (·81) is of doubtful value as an indication of the primitive form of the cranium.

The supraorbital ridges are very strongly marked, their real prominence being much exaggerated by the retreat of the forehead. There are no distinct paroccipital processes. The crowns of the teeth are ground down quite flat.

Although the two skulls sent by Dr Cunningham are from Patagonia, it does not absolutely follow that they are Patagonian in the ethnological sense. The Caribs were great voyagers, and some may have strayed as far south as the coast of Patagonia, and left their bones in a sand-bank.

The facts which have been adduced, however, clearly tend to the conclusion that brachycephaly obtains among the Patagonians, and dolichocephaly among the proper Fuegians; and therefore that these two types of cranial conformation exist side by side at the southern extremity of America.

There are only two undistorted or little distorted crania of 'Guarani' Indians in the Museum of the Royal College of Surgeons. Of these, No. 5405, the skull of a Macusi from Guiana, has the cephalic index ·81. No. 5406, the skull of an Arawack, also from Guiana, has the cephalic index ·80. These two skulls, therefore, though actually brachycephalic, are close to the boundary between brachycephaly and dolichocephaly, and

differ very widely in degree from the more brachycephalic Patagonians.

I do not know that any satisfactory evidence exists as to the natural form of the skull in those North American tribes, such as the Chenooks, in which it is artificially flattened. Leaving these out of consideration, strongly marked brachycephaly seems to be restricted in the New World to (1) the ancient inhabitants of the Mississipi Valley, the so-called "Mound-builders"; (2) the Patagonians, and more or fewer of the Southern Americans westward as far as Peru.

Strongly marked dolichocephaly, on the other hand, is found universally among the Esquimaux; greatly predominates among the Northern Red Indians, and the northern inhabitants of South America; and (if one skull is sufficient evidence), is met with in so much of Tierra del Fuego as is inhabited by Fuegians.

Confining ourselves to people with black hair, and yellowish, reddish, or olive brown complexions—not differing more widely from that of the Americans than the Americans do from one another—we find that dolichocephaly is continued by the Tchuktches (Wilson), the Tunguses (Retzius), the Japanese, the Ainos and the Chinese, into Asia, and terminates at undefined points on the northern and eastern shores of that great continent.

Brachycephaly of a marked kind predominates in the Aleutian Islands (Von Baer), but is probably not to be met with on the Asiatic coast of the Pacific and Indian oceans more northward than Siam, or more southward and westward than the valley of the Ganges.

Westward and northward from Siam, so far as our information at present goes, people with yellowish-brown complexions, black hair and brachycephalic skulls, extend across central Asia to Lapland. Southward and eastward they abound in the Malay Archipelago, and may be traced into the Samoan islands and the Sandwich islands in Polynesia.

From China and Japan southward and eastward dolichocephalic people with black hair and yellowish or reddish brown

complexions are to be found (as Dyaks) in Borneo. The cranial characters of the Battas of Sumatra are not sufficiently known. Probably they will be found to be dolichocephalic like the Dyaks; and I believe in all the Micronesian and Polynesian islands—constituting the entire population of some of them, such as New Zealand.

Westward, dolichocephaly combined with yellowish or reddish brown complexion and black hair, appears in a marked form among the inhabitants of the Canary islands, of Cis-saharal Africa, and of Egypt; and, not improbably, in former times, extended much further to the north and west than at present.

On either side of the vast belt of people with black hair and eyes, complexions varying from yellow to olive-brown, and skulls of the most extreme proportions—which has thus been traced in occupation of the Americas, of the greater part of the Pacific islands, of Asia, of northern Africa, and perhaps of southern and western Europe, we find other stocks, in some of which the characters of the skull are as apparently variable as in these; while in others, the skull has a singularly unnatural form.

Thus, northwards, in western Asia, in Europe, and sending offshoots into northern Africa and Hindostan, are the Xanthochroi, with fair skins, light hair, and blue eyes; who offer in the Scandinavian and in the south German the extremes of dolichocephaly and of brachycephaly.

On the south, on the contrary, the dark-skinned people with black wavy hair, and black eyes, who primitively inhabited Australia and the Dekhan, are, I believe, invariably dolichocephalic.

The people with black, crisp, or woolly, hair, and black eyes, who inhabit Ultra-saharal Africa, and sundry islands in the Indian and Pacific oceans, and are known as Negroes, Negritos and Bushmen, are almost as invariably dolichocephalic. At least, I know of not more than two or three cases in which the cephalic indices of these people have reached or slightly exceeded ·80.

THE RELATION OF DIGESTION AND DYSPEPSIA TO OSMOSIS. By WM. MURRAY, M.D. M.R.P.C. Lond., *Lecturer on Physiology in the College of Medicine, Newcastle-upon-Tyne*[1].

WHILE pathological anatomy inclines us to seek for an explanation of the symptoms of disease in the structural alteration of the organs whence the symptoms arise, physiology directs our attention to remote parts of the system with which the disordered organ deeply sympathises or to which its functions are intimately related. Physiology, for instance, instead of directing our attention to the structure of the kidney (or the eliminating organs) for an explanation of Diabetes, suggests to us the better path of inquiry into the state of the processes carried on in the assimilating organs of the body. Pursuing this latter course of inquiry, we may possibly be led to see that the assimilating organs in their turn are less frequently than is generally supposed the true source of the symptoms expressed by their disordered action. Indeed, we may find that in most cases Dyspepsia is not related to the stomach at all as effect is related to cause; no more so than gout is dependent on the state of the big toe previous to an attack of that disease, or pericarditis on the state of the heart previous to an attack of acute rheumatism. If this be true, even to a limited extent, its immense practical importance in the treatment of gastric disturbance is at once my plea for a patient hearing and a considerate judgment of the crude theory I am about to submit.

Perhaps no organ in the body is so subject to faulty and disordered action as the stomach, even when dieted with food most convenient for it. Many people complain more or less of the uncertainty of its action; and yet, in many of these chronic dyspeptics, a most careful examination of the coats of

[1] See paper by same author on 'Osmosis in relation to the Physical and Physiological action of Medicines,' Vol. I. of this Journal, p. 319.

the stomach after death fails to detect any serious alteration of its structure. In these cases, at least, we are justified in looking elsewhere for an explanation of the symptoms manifested during life. As an explanation of the view I am about to propose let me state, thus early in my paper, that in many cases indigestion does not result *directly* from overloading or overfilling the stomach, but from the stomach having overfilled the blood and from the blood having overfilled the tissues, or rather from the supply of nutriment to the tissues and blood not having been sufficiently exhausted before the stomach is refilled. The stomach, as I have observed again and again, may be absolutely empty, moreover, it may at the same time be in a perfectly healthy state, and yet, from a want of action in the excreting organs, or from a want of exercise and waste of the nervous and muscular tissues, such a stomach is certain to refuse a good digestion to its contents, and to give rise to symptoms of dyspepsia. On the other hand, a very weak stomach, and a very disorderly stomach, will under certain conditions of the blood and tissues assume most marvellous powers of digestion, and cannot be overfilled. For example a man, usually dyspeptic, takes fever, and vomits almost everything administered to him for fourteen days, passes the crisis of the fever, begins to crave for food, which may be given with perfect safety, and in a day or two eats two or three times as much food as ever he did before in an equal time. Again, a patient has long complained of indigestion, says it is his greatest enemy, and cannot or dare not eat much; but slowly he observes a change in his digestive powers, rejoices in his increase of appetite, and "good digestion waits on appetite," when to his surprise his physician tells him that Diabetes is the cause of both his appetite and increased digestive powers. Here then is a statement of our case. "There are instances in which the state of the blood and tissues, as dependent on the action of the eliminating organs and of the muscular and nervous systems, is the only real cause of Dyspepsia, and digestion is increased or diminished just as the state of the blood and tissues may determine it." We shall now proceed to show how these conditions of the blood and tissues operate upon the functions of

the digestive organs. The force whose operation determines those digestive powers of the stomach above referred to is that which carries on the various forms of Osmose in the body. We know well that the osmotic processes maintain the balance of all the vital fluids, preserving to each of them the Specific Gravity necessary for the office it has to perform. Among the fluids a strict relationship in this respect is thus provided for. The maintenance of this relationship is of course most important in the case of the blood, because it is to and from this central fluid that all other fluids come and go in absorption and secretion. For instance, a very heavy condition of the blood being induced by the removal of a large amount of its watery constituents would lead to a rapid absorption of liquid food, and slow absorption of solid food; while a great waste of solid matter would lighten the blood and lead to the rapid absorption of fluids of a very high specific gravity, *i. e.* fluids laden with dissolved food. Without doubt there is continually going on in the body a kind of ebb and flow of osmotic activity, at one time the processes are most active at the absorbing surfaces, at another at the excreting or secreting surfaces. The tide turns in the one direction or the other according to the state of the blood. When the blood is replete from absorption its contents are at once absorbed into the wasted and hungry tissues, or thrown out of it by the secreting and excreting glands; and, on the other hand, when it has thus become exhausted, it presents to the absorbing surfaces of the alimentary canal a favourable condition for their activity. Before proceeding to apply the above consideration to the study of Digestion or Indigestion, I would advert to the still more intimate relationship the osmotic currents bear to the structural elements of the blood and tissues. No doubt the absorptive power each cell possesses is dependent upon the conditions of the fluids by which it is surrounded; and among the correlated forces at work in cell life *this we speak of* plays its part. A cell is a small osmometer, in which may be measured the rapidity with which nutriment fluids pass in and waste matter passes out. This osmosing power of cells may be witnessed in the blood itself, when its cells are examined in fluids of various specific gravity;

at one time its cells are seen to be distended and round when the fluid is light, while they become flat and shrivelled when they inhabit a heavier medium.

Let us now, for a short time, consider the various conditions of the body recognised as conducive to good digestion, and see whether they are related to that state of blood which we have seen to be favourable to the absorption of food from the digestive organs; and then I will call attention to those opposite states which are unfavourable to good digestion, and point out the condition of the osmosing streams (blood, &c.) in each condition.

I have already shown that Diabetes is often accompanied by large powers of absorbing alimentary matters, and I have shown that the starved condition of the blood and tissues in convalescence from acute wasting diseases powerfully increases the digestive and absorbing power of the stomach. In each of these cases the state of the tissues and the blood are the real source of the power of the stomach to deal with large quantities of food. In the same category we may place those cases where vigorous exercise restores the tone and power of weak and sluggish digested organs. The increased exercise tells first upon the tissues, exhausts and unloads them, creating a demand upon the blood for increased reparative material, and so prepares that fluid to take up larger quantities of food from the digestive canal. This demand for food is so commonly attributed to its right source that I need only advert to it, to point out the true mode in which it acts. Increased oxidation has a similar action on the tissues, and therefore a similar effect upon digestion. Fresh air we all believe brings appetite and good digestion with it. It does so, not by direct action on the stomach, but indirectly through the rapid tissue change it induces. In the same category we may put the man who constantly craves for food and digests it without any increase of nutrition. The craving of the stomach and the rapid digestion of these lean men, is constantly accompanied by great activity either of body or mind. We say they are no better for what they eat, because the supplies reserved by the tissues are so rapidly disposed of and a fresh demand on the digestive organs

is thus so rapidly created; by way of contrast we might instance the case of some stout and lazy people who say they live on almost nothing, and have a very small appetite. In these the tissues change slowly, and the osmosing current is never sufficiently exhausted to draw largely on the absorbing surfaces. We admit of course that in many of these cases there are unaccountable peculiarities forming exceptions to the above rule; but even in these the large and small appetites often depend chiefly on a natural tendency to rapid tissue change in the one and slow tissue change in the other. The diet used by each individual will of course have another material influence in many cases, but I believe that most people are instinctively prompted by the very law we are speaking of, to eat the food most demanded by the tissues of the body. Space forbids me to give further examples of the fact that all those conditions of health which increase the appetite do so by wasting the tissues and drawing on the blood. Side by side with this we must put the condition of the secreting, and excreting or eliminating organs of the body in relation to digestion and appetite. It is needless to go into this part of the subject, for we all admit that a sluggish state of the intestinal secretions, or of the liver, or of the kidney, or of the skin, or of the pulmonary *gaseous* excretions, tends to stop digestion, while a vigorous flow of these secretions tends to give a powerful and healthy action to the digestive apparatus, and especially to its absorbing functions. Confirmatory of this is the striking effect of eliminative and alterative medicines which do not act on the stomach at all. A good purge, a diuretic, or the Turkish bath, each promotes the action of the stomach on its contents in the way we have indicated.

We have now to consider the second part of our proposition: "those conditions of the body which are accompanied by small digestive powers are usually related to a diminished capacity for osmosis on the part of the fluids." We may advert first of all to the converse of all those conditions before enumerated as favourable to digestion. Fever before its crisis, finds its subject laden with non-eliminated matters circulating in the blood and the supply of these matters to the blood is kept

up by the oxidation of tissues which for the time admit of no repair. So also with the converse of healthy exercise in repose of mind and body. The digestive powers fail to deal with large quantities of food, and the usual quantities which may have been suitable during periods of exertion most certainly lead to Dyspepsia, unless, as is not uncommon, the individual have large capacities for storing up food in the system; then the absorption of carbonaceous matter by the adipose tissues may enable the blood to go on receiving large supplies from the stomach without indigestion. Should this not take place, indigestion will certainly follow. What is called Biliousness is frequently this very state of things; the blood is replete, the tissues are not wasting, and will not receive nor store its supplies; a heavy meal is then rejected by the absorbing surfaces with the usual symptoms of indigestion described as bilious. In this state of things a free action of the bowels, or the liver, or a good dose of calomel, which leads (as I have shown in my former paper in this Journal, Vol. I. p. 319) to a free metamorphosis of tissues and the elimination of effete matter, at once puts the patient right for the time. Such a person, thus relieved, goes on eating and reposing again till the same state of things ensues and he is for ever being put right by means of Blue Pill and Black Draught. It is our duty as physiologists to point out that this is a very unnatural mode of restoring the absorbing powers of the stomach, and to insist on a more natural method, either by giving less food or more healthy work. This is the cause of the dyspepsia of nine-tenths of our patients who spend their lives in offices in routine work without mental exertion, and of almost all the dyspepsia of well-to-do people who won't work and will eat. The same rule holds good with regard to nitrogenous food, and with greater force, because it cannot be stored up like fat in sluggish tissues, nor can it be eliminated so easily by the kidney. The influence of diuretics, exercise, and fresh air is its only antidote.

It remains for me to say that there are many cases of indigestion in which the osmotic power of the fluids plays a very subordinate part. It is quite possible, for instance, to have the most exhausted condition of the tissues and a powerful capacity

for osmose in the blood without good digestion. Such a condition prevails in Phthisis, where the disease essentially consists in some profound and subtle change in the epithelial absorbing surfaces and in the assimilating organs whereby the osmotic processes are arrested. Again, the various kinds of indigestion are often associated with structural alterations of the stomach, which interfere with the application of the above remarks to those varieties of that disease. But we affirm that in all these cases a subordinate part is performed by the osmosing condition of the membranes and fluids, a part sufficiently important to be recognised in the treatment of all cases. But we are certain that in many other cases, such as we have enumerated, it plays the *most* important part, and treatment to be successful must be specially directed to it. Calomel, and all mercurials, the alkalies, potash and soda, purgatives, sudatorial remedies, diuretics, and the various cholagogues, doubtless derive most of their usefulness from their power to increase the absorbing (osmosing) powers of the digestive mucous membranes, and to promote the passage (osmose) of nutrient matter from the blood into the tissues. If their value does not end here it is because they have a further power of causing the metamorphosis of sluggish tissues and of eliminating (osmosing) waste matter out of the blood. (See action of Calomel in first paper.)

(*To be continued.*)

ON THE PREPARATION OF FIBRINOGEN AND FIBRINOPLASTIN. By W. H. ALLCHIN, *Assistant in the Physiological Laboratory, Sub-curator of the Museum of Anatomy and Physiology, University College, London.*

THE trouble in obtaining the constituents of fibrin from fluids in which they are contained by the carbonic acid process has long been recognised, and the further difficulties of washing and drying have rendered the plan most unsatisfactory for the purposes of class demonstration.

Having had occasion to prepare for Dr. Foster a considerable quantity of fibrinogen and fibrinoplastin, I adopted the following method after that proposed by Denis for obtaining his so-called plasmine. It is based upon the behaviour of these bodies towards solutions of neutral salts; for whilst they are soluble in aqueous solutions of those salts of a certain strength, their solubility is diminished the further that point is departed from.

The fluids used were the serum of bullock's blood for fibrinoplastin, and the pericardial fluid of the horse or hydrocele fluid for fibrinogen; these were taken as received and saturated with crystals of sulphate of magnesia or chloride of sodium. The fibrinogen (or fibrinoplastin) is thrown down as a white bulky precipitate. The fluids thus treated may be quickly and easily filtered and the precipitate washed with a saturated solution of the salt employed, or may be more completely freed from colour by redissolving in a weak solution of the salt and reprecipitate.

The filters may be dried at a low temperature and the material remaining on them scraped off, powdered, and preserved in stoppered bottles.

The simplicity of this plan with the short time required for its performance, recommend it for class purposes, as the entire process of preparation and subsequent clotting may be demonstrated easily during the lecture hour.

Although the fibrinogen and fibrinoplastin thus prepared in combination with sufficient salt to allow of their solution in water, exhibit the characteristic properties of these bodies, our knowledge of them as yet is not sufficiently exact to permit of our accepting this process as an accurate means of obtaining them for the purposes of analysis.

ON THE NOURISHMENT OF THE FŒTUS IN EMBIOTOCOID FISHES. By James Blake, M.D. Lond., F.R.C.S.

The manner in which the young of the embiotocoid fishes is nourished until it escapes from the ovary has not, that I am aware, been satisfactorily explained. In this class of fishes the young remain in the ovary until they are apparently as perfect as the adult fish. As during the process of gestation the ovary is cut off from all communication with the water, the external orifice being sealed up by a dense layer of epidermis or inspissated mucus, it is evident that the fœtal fish must receive the elements of its growth from the interior of the ovary, and that it must be furnished with organs of absorption and respiration suited to the medium in which it is developed. A large supply of nourishment must evidently be required, as the ovary contains frequently forty or fifty young fish, which when fully developed measure more than two inches in length, and which together will weigh from one-twelfth to one-sixteenth as much as the parent fish. The ovary consists of a membranous bag partially divided at the upper part, and terminating below in a narrow canal, which, in some species, opens externally in a cloaca common to it and the urethra, in others, by a separate opening situated between the anus and urethra. The sack has three coats—a peritoneal, a muscular, and a mucous. The mucous layer is thrown into a number of longitudinal folds, which are attached to the upper side of the uterus. On these folds, and on the inner surface of the ovary, the ova are found; and as the fœtal fish grows these folds extend so that each fœtus is in contact by each of two surfaces with the mucous membrane. The organ is well supplied with blood-vessels, an artery entering at each horn of the ovary. They arise from the aorta immediately after the union of the branchial arteries; and at the latter end of

gestation each is larger than the descending aorta. The posterior part of the uterus also receives vessels from the abdominal aorta. In the early stages of developement the fœtus is embedded in a very tenacious secretion, which resembles para-albumen, in that it can be drawn out into threads of a foot or eighteen inches long. As gestation advances, the secretion of the ovary becomes more fluid, and its quantity is increased so that as much as three drachms can be obtained from one ovary towards the end of gestation. It then forms an opalescent fluid sp. gr. 1025; does not coagulate on heating; acetic acid throws down a white precipitate, mixed with equal parts of distilled water, and, filtered, it has no action on polarized light: heated in an open vessel a pellicle forms on the surface. It probably contains some albumen-compound, fat, salt-phosphates, and iron; but it has not been submitted to a careful analysis[1]. The fœtus, during the earlier stages of its developement, goes through changes apparently analogous to those which take place in the ova of oviparous fishes, and it is not until the fins are formed that any departure from the ordinary plan shows itself. As soon as the fins were well formed, the dorsal, caudal and ventral fins become edged with a delicate membrane formed apparently entirely of capillary blood-vessels. As the fœtus grows this membrane is split up into processes or digitations which extend a considerable distance beyond the margin of the fin, sometimes as much as a quarter of an inch. They retain the same structure during the whole period of developement, and are so extremely delicate, that I have been unable to detect them in any specimens preserved in alcohol. As soon as the young fish is expelled from the ovary, these processes rapidly diminish in size; and, I have no doubt, they entirely disappear after a few hours. Their use is evidently to absorb nourishment from the fluid in the ovary; they also serve to aerate the blood; for I have observed that on heating the fluid from the ovary, or on mixing it with ether,

[1] This fluid is usually expelled from the ovary by the struggles of the fish when taken from the water, so that it is extremely rare to find one in our market in which the membrane closing the orifice of the ovary has not been ruptured. This is probably the reason that it has not been already noticed.

there is an abundant escape of gas. I think these facts serve to explain the manner in which the fœtus of the embiotocoid fishes is nourished during its intra-ovarian developement. They have been frequently observed in the three varieties of this sort of fish which are found in our waters.

As regards the process of copulation in these fishes, I would observe that the male possesses a tubercular penis somewhat analogous to that of the shark. Except at the time of copulation it is not provided with any organs of prehension, but as the testicles become developed two sucker-like fleshy processes grow out, one on each side of the ventral fin, about two-thirds of an inch from the penis. These processes are apparently developed only at the time of copulation, as I have never detected them whilst making observations on these fish when the young were being developed in the female.

San Francisco, Cal.

NOTICE OF A CASE OF MALPOSITION OF THE RIGHT KIDNEY. By Alex. Davidson, M.A. M.B. Edinburgh. *Lecturer on Comparative Anatomy in the Liverpool School of Medicine.*

In making the *post-mortem* examination of the body of a female child, aged 7 years, who died of acute disease, it was found that the right kidney was situated in the middle line on the promontory of the sacrum, its superior margin being at the middle of the fourth lumbar vertebra. It was attached by connective tissue to the front of the spine. It was irregular in shape, the posterior surface smooth, the anterior lobulated. From the latter the ureter arose by four distinct roots, which joined immediately; below the junction the duct pursued its normal course. The renal branch of the aorta entered the superior end of the kidney, and on the right side an additional branch was derived from the common iliac artery. There was no supra-renal capsule on the right side, whilst that on the left was large. The left kidney, heart, and other viscera were normal.

ON THE HOMOLOGIES OF THE FLEXOR MUSCLES OF THE VERTEBRATE LIMB. By ALEXANDER MACALISTER, L.K.Q.C.P., L.R.C.S., *Demonstrator of Anatomy, Royal College of Surgeons, Ireland; Surgeon to the Adelaide Hospital.*

AMONG the most definite and easily recognized of the muscles of the Vertebrate Limb are those devoted to the flexion of the forearm or leg, the 'pre-humeral' muscles of the upper limb, and the 'hamstrings' in the lower. Yet, while they are easily recognized as a group, and are without difficulty distinguished from the neighbouring adductors and extensors, when we examine the components of the series in the range of vertebrate animals, we find some difficulty in referring them to a proper and regular series of types. If we believe that all vertebrate limbs are constructed after a definite fashion, and that their component parts are the modified organs of a typical extremity, varied to suit individual circumstances in the economy of each animal, it becomes an interesting study to determine, from the sum of the details of many vertebrate limbs, what are the typical muscles of the flexor series.

Of the flexors in the upper limb we find considerable variety; in *man* we have normally three, occasionally, four. These are the gleno-radial or long head of the biceps, the coraco-radial or short head of the biceps, and, more rarely, the humeral head of the biceps, present in the proportion of once in nine subjects, according to Theile[1]; a proportion which I found correct during last winter session, as out of sixty subjects examined it occured seven times. This human type of arrangement is common among the quadrumana existing in *macacus, simia,* and *cerco-pithecus.* In *ateles paniscus* I saw once the biceps sending a slip to the supinator longus. Among the *Lemuridæ* the biceps possesses one head only, in *Stenops*[2] a gleno-radial,

[1] Theile, *Encyclopædie Anatomique,* III. 217.
[2] Meckel, *Anat. Comp.* VI. 291.

and the same occurs in *Nycticebus*[1]. *Tarsius* and *Cheiromys*[2], however, have two heads each for the muscle. Among CARNIVORA we find some little variety of arrangement in the flexor group. In the *dog* the biceps has a single origin, as we likewise find in the *seal* and the *otter*, the *cat*, the *lion*, *racoon*, and *weasel*. The *bear* has a coracoid origin, as Cuvier and Meckel both remarked. This certainly exists in the *brown bear;* and the latter author mentions it in the *white bear*. In *nasua*, Meckel notices that the biceps is joined to the brachialis anticus by a tendinous slip. In the *badger* and *marten* it has but a single head. The brachialis anticus in these shows but little deviation, in course or attachments, from the human type. The CHEIROPTERA likewise exhibit these muscles arranged in a series of three. The biceps has a humeral as well as a coracoid head, and no long glenoid origin; it is inserted into the radius. The brachialis is slender and normal.

Among the INSECTIVORA we find the biceps reaching an enormous size in the *mole*, and attached to the radius; in *Erinaceus* and *Sorex* it is attached to the ulna.

The RODENTIA, an order usually characterized by muscular peculiarities, exhibit these muscles in a two-fold state. The *rabbit* and *hare* possess the gleno-ulnar form of biceps; so does the *porcupine*, the *agouti*[3], *beaver*[4], *guinea-pig*, and *paca*[5]. In the *marmot*, Meckel describes the biceps as attached to the radius, and retaining but one head. The brachialis anticus is divided in the *rabbit* and *hare* into two parts; also in the *Dasyprocta cristata*, according to Messrs Murie and Mivart; but it is not similarly cleft in the *guinea-pig*.

Among MARSUPIALS the variations of these muscles are often of singular interest. In the *giant kangaroo* and *wallaby* the biceps is divided into two parts for its entire extent, of these the coracoid origin is generally the larger, and it runs to be inserted into the tubercle of the radius; the glenoid origin is smaller and as usual tendinous; crossing the head of the hume-

[1] Mivart and Murie *on Nycticebus*, *P.Z.S.* 1865, p. 244.
[2] Owen *on Cheiromys*, *T.Z.S.* VI. 60.
[3] Mivart and Murie *on Dasyprocta*, *P.Z.S.* 1866, p. 399.
[4] Meckel, p. 288.
[5] Mivart and Murie *on Hyrax*, *P.Z.S.* 1865, p. 338.

rus, and crossing the coraco-radial muscle, it is inserted into the ulna in company with the brachialis anticus, whose origin is principally from the outer side of the humerus, outside the crest for the deltoid, but in front of the prominent exo-condyloid ridge. In *Didelphys* and *Phalangista* the muscles are similarly arranged, as they are likewise in all the other marsupials which I have examined.

The PACHYDERMS exhibit two flexors. In the *rhinoceros*, Prof. Haughton and I found the biceps to arise by an enormously strong tendon from the coracoid process, and to be inserted into the radial tubercle. The brachialis anticus also is inserted into the same locality. In the *pig* there is a single origin for the biceps, and its insertion is both radial and ulnar. In *Hyrax* the biceps is gleno-ulnar: in the *horse* it is gleno-radial, but exhibits a trace of a division. The brachialis in the *pig, horse, hyrax*, and *rhinoceros*, shows nothing distinctive.

Of the RUMINANTS several show interesting varieties of arrangement: in the *camel* the biceps is gleno-radial, but, according to Meckel, exhibits a trace of a division (p. 285): the *sheep* likewise possesses a simple gleno-radial flexor, and a humero-radial one as well, in the form of a brachialis anticus. The *goat* is similarly circumstanced. I found but one head to the biceps in *cariacus virginianus, dama, wapiti*, and in the *napu deer*. We could not expect to find a coracoid origin in any of these animals, as that process is reduced to a minimum in ruminants.

In CETACEA, as we might expect, there are no distinct muscles taking the place of these flexors in front of the short discoid humerus. In *Balænoptera rostrata* a tendinous band runs down in front of the bone, which probably is the representative of the biceps; but in *Globiocephalus, Delphinus*, and *Phocæna*, there is no distinct trace of it even as a tendinous fascicle.

The EDENTATES present the following arrangements; the *Dasypus septemcinctus* has a single head for the biceps; and the *ant-eater*, according to Meckel, has only a simple glenoidal origin; but it is inserted, as in the pig, into the radius and the ulna. The same author tells us that in *ai* there are two heads, one, glenoidal, whose fibres are inserted into the ulna, and the

second, a humeral fasciculus, which is inserted into the radius (p. 287).

Among the MONOTREMATA they exist as follows. In *Echidna hystrix* there is only a coracoid head present for the biceps, which is inserted into the radius and ulna. Mr Mivart[1], to whom we owe our knowledge of the myology of this animal, describes a slender brachialis anticus arising outside the deltoid as usual. In *Ornithorhynchus* there are two heads for the biceps, both from the coracoid apparatus, and inserted into the middle of the radius. In thus briefly reviewing the orders of Mammalia, we see that in Rodentia the biceps is *gleno-ulnar;* in Ruminantia, *gleno-radial;* while in some pachyderms, monotremes, and marsupials, it is *gleno-radio-ulnar* in its course. The brachialis anticus preserves a striking and almost undeviating uniformity throughout the entire series.

Among BIRDS these muscles present some few varieties. The coraco-radial muscle exists in the *rhea* and the *ostrich*. In the majority of birds, however, the superficial flexor is a true biceps, having a humeral as well as a coracoidean head, and a double insertion into the radius and ulna: it is very strong in the *falcon* and *monk vulture,* well marked in the *domestic fowl,* but, according to Meckel, absent in the *penguin*. It has only one head in the *guillemot,* according to the same author. Among Reptiles we find in the *crocodile* that there are three flexors, a biceps cleft for its whole length and inserted into the forearm bones, and a distinct brachialis anticus.

In the CHELONIAN group of reptiles the brachialis anticus is inserted into the ulna in *Testudo* and *Emys*, and into both bones in *Chelone*. The superficial flexor is inserted either into the radius or ulna; in *Emys geographica* it is inserted into both bones; in *Testudo græca* into the ulna; and in *Chelone mydas* into the radius, and a fascia at the radial side. The BATRACHIANS possess a coraco-radial flexor, which is present in the *frog* and *toad*. In the *Proteus anguinis* the flexor is a humero-radial muscle, but the maculated *salamander* possesses a true coracoid flexor. Of the LIZARDS the following present us with variations of arrangement. In the common *Lacerta agilis* the

[1] *Trans. Linn. Soc.* xxv. 386.

flexor is coraco-radial: and the same muscle exists in the *iguana*. In the *chamæleon* the flexor is inserted into the radius and ulna.

When we examine the leg flexors of the vertebrate series, we find that similarly there are four typically developed. In *man* these are the biceps with its ischial and femoral origins, the semimembranosus and the semitendinosus. These muscles present fewer varieties than their arm congeners, because their use is less varied; and, consequently, there is less necessity for following their individual details in the animal series. Of the four above-mentioned, the semitendinosus is a muscle of considerable interest, and presents an appearance of great value in comparative myology, namely, a tendinous intersection which extends completely through the muscle. This appearance, wherever found, is suggestive of a union of two separate muscle-germs, as we shall see hereafter.

Taking the sum of these individual arrangements, we learn that in the arm and leg there are respectively four flexor muscles in each limb, of which all the instances detailed above are various modifications.

1st. Of these four one is developed as a coraco-radial or ischio fibular muscle. This is characterized as most frequently present, and most strikingly retaining its typical position and attachments; it is the most external of the true flexors in its point of insertion, although, in some instances, not the outermost at its immediate origin; in man it forms respectively the short head of the biceps cubiti, and the long head of the biceps cruris.

2nd. The second muscle is a shorter or humeral (femoral) muscle on the same side of the limb, often being fused in its insertion with the last named. It is present and typical in the *rhinoceros, sheep, ai,* and *proteus;* it is united to the preceding muscle in the human thigh normally, in the human arm occasionally, as the third head of the biceps; and normally in the arm of *cheiroptera*, and in the thighs of other mammals.

3rd. The third element in the long flexor series is the muscle developed as gleno-fascial or ulnar in the human and other brachia. It is present in the *hedge-hog, rabbit, hare, porcupine,*

agouti, beaver, guinea-pig, marsupials, hyrax, and *ai.* In cases in which the coracoid process is not developed, we sometimes find that the first muscle originates from a tendon which corresponds with the typical origin of this flexor; and hence we have the compound gleno-radial muscle of the *ruminants,* in which however, as Meckel indicates, a trace of a division may be seen (vide supra), and the more distinctly composite muscle in the *horse* is formed in the same manner; an intermediate condition obtains in the *pig,* in which, from a single origin, the biceps seeks a radio-ulnar insertion. The reverse of this obtains in *emys geographica* and the *chamæleon,* where, from the coracoid origin, a doubly inserted muscle springs. Another interesting variety of this muscle is to be found in the human thigh, where we find this muscle represented by the lower part of the semitendinosus below its tendinous intersection, as evidenced by its internal insertion and its fascial connexion, which reminds us strongly of the semilunar fascial expansion from the gleno-ulnar muscle in the fore limb; but it is obvious that the portion of this muscle above the tendon is only a supplemental part of the long head of the biceps, and not a part of this type. Now in the fore limbs of those animals which exhibit this muscle the most typically, it has a long tendon of origin placed most external in its attachment to the basal limb bone; and these conditions we find exactly fulfilled in the human limb by the tendon of origin of the semimembranosus. These two elements taken together, that is, the tendinous origin of the semimembranosus and that portion of the semitendinosus below the "inscription," represent, with great distinctness and accuracy, the type gleno-ulnar muscle before noticed.

4th. The last element in the flexor group is that of which the brachialis anticus is the typical form. It is a humeral or femoral muscle in its typical origin, and tibial or ulnar in its insertion. It is normally present in the human arm, and that of the *quadrumana, carnivora, cheiroptera, rodentia, marsupialia, pachydermata,* and *monotremata.* It is present and fused with the coraco-radial in the majority of *birds;* but it retains in these its individuality of insertion into the ulna, especially in the waders and water birds, such as *platalea, ardea,* and *ciconia.*

It is present in *emys* and *testudo*, and fused with its congener No. 2 in *chelone*. In the human leg we find it typified by the semimembranosus, when we deprive that muscle of the tendon which it has borrowed from the semitendinosus origin, whose loss has forced the latter to contract an adhesion to the biceps. Its insertion in the leg and arm are exactly similar in position in relation to the joint and to the longer flexor No. 3. The tendon of origin of the semimembranosus is not as closely connected with the joint as that in the upper limb; but the intra-articular part of the biceps tendon seems to be represented by the ligamentum teres coxæ. In comparative anatomy it is interesting to find that while this muscle holds its typical form in the fore limb, it is constantly the subject of this modification in the hinder limb. We find it thus in the *wallaby* and *phalanger* and in the majority of mammals. In *ai*, *kangaroo*, and *castor*[1], the semimembranosus and tendinosus arise in common, while in *loris*, Meckel says, that the semimembranosus and biceps are united[2]. In the *emu*, however, we find it typical, but supplemented by a long detached slip of the biceps, so as to form a bicipital muscle (Haughton, P. R. I. A., April, 1866). In *rhea* the arrangement is similar; but its long accessory is a prolongation of the glutæus maximus, and not of the biceps. In most ruminants, as the *sheep*, *goat*, *deer*, *nylghau*, and *cariacus*, this muscle arises from the adductor magnus, and, in these, the semitendinosus is normal and complete. Briefly reviewing our survey of these muscles, we see that they fall into their places most accurately as duplicate flexors, Nos. 1 and 3 being long flexors, one for each of the bones of the forearm and leg; and Nos. 2 and 4 being a pair of shorter flexors for the same bones. In this arrangement, surely, we have an instance of a wonderful symmetry of type-structure fully equal to that of any other series of organs in the animal kingdom.

NOTE. In an armadillo dissected by me, April 7, 1868, there were two heads for the biceps, and Dr Haughton informs me that he has met with the same. In a specimen dissected by me last month, however, there was but one head. The coracoid head was in the two former cases one-half the size of the glenoidal.

[1] Meckel, Vol. VI. p. 383. [2] *Ib*. p. 384.

ON THE MYOLOGY OF ORYCTEROPUS CAPENSIS AND PHOCA COMMUNIS. By PROFESSOR HUMPHRY. (Pl. III. IV. V. VI.)

I PROPOSE to give a brief description of the muscles of these two animals together, because I have lately had an opportunity of dissecting them both; and there are some advantages in doing so. My attention has been chiefly directed to the muscles of the limbs[1].

Though so dissimilar in their habits the two animals are alike in the want of definition between the limbs and the trunk, owing to the manner in which the proximal parts of the limbs, which are short, are enveloped in folds of skin passing over them from the trunk, obscuring their outlines, and limiting the range of their movements. Thus, in both, the skin passes from the side of the body straight across to the elbow, making the forearm to appear the first segment of the limb; and the folds between the digits extend in Orycteropus as far as the second phalanges, and in Phoca even beyond the phalanges. In the case of the hinder limb, the thigh, in Orycteropus, is bent upon the abdomen and obscured by a fold of skin passing from the trunk directly to the knee; while another fold passes from the tail and hinder part of the pelvis, over the back of the leg, and reaches almost to the heel. In Phoca the knees are bent up beneath the abdominal muscles and the two hinder limbs are enclosed with the tail for some distance, in one fold, so as to form a flattened termination to the animal, reminding us, not a little, of the tail of a Cetacean; the wing-like processes of which might seem to be represented by the laterally expanded feet of the Seal. Both the Anteater and the Seal are furnished with long strong claws, those of the Anteater being

[1] I am not aware that the muscles of Orycteropus have been described. They are scarcely touched upon by Rapp, *Anatomische Untersuchungen über die Edentaten*. Tübingen, 1858, or by H. F. Jäger, *Anat. Untersuch. des Orycteropus Capensis*. Stuttgardt, 1837. The muscles of the Seal have been more or less fully described by Meckel, Duvernoy, and others.

particularly thick and strong to enable it to burrow rapidly in the earth. In both the bones of the limbs are thick, hard and strong, with rough strongly-developed processes for the attachment of muscles; the olecranon is very large, the tibia and fibula are confluent above, though separate below; the pelvis is prolonged backwards, and the obturator holes, especially in the Seal, are large.

There are, however, some marked differences.

In the Seal the terminal parts of the limbs, especially of the hinder limbs, are large, and spread out fan-like, the digits being thin, long, of nearly equal length, and in the same plane; and the size of the fan is increased or diminished, in each foot, chiefly, by the distancing or approximating of the other digits to the first, and the lateral movement of the digits therefore increases from the first to the fifth. The dorsal and plantar surfaces of the terminal parts of the hind limb are in the same plane with those of the leg; the projecting part of the heel-bone, which is small, is drawn forwards or upwards, and the hinder part of the astragalus, carrying the groove for the flexor tendon of the toes, is drawn up with it and projects nearly as far. The lumbar and hinder five or six dorsal vertebræ are constructed so as to admit of full antero-posterior movement; whereas the iliac bones are short and directed outwards, presenting flat surfaces anteriorly; and the ischiatic bones, though long, are slender, showing that the muscles which pass from the pelvis to the short thighs are small. These features have, of course, relation to the fact that the propulsion of the animal is effected not, as in ordinary mammals, by the movements of the limbs upon the pelvis, but rather, as in the fish, by the movements of the hinder part of the vertebral column upon the rest of the trunk, the limbs of the Seal serving chiefly, like the tail-rays of the fish, to give width to that part of the column. In the Anteater the distal segments of the limbs are short, the bones being thick and strong, with many accessories or sesamoids. The digits are compressed together, and are not all in the same plane, the two lateral digits (1st and 5th) in the hind limb, and the 5th (the 1st is wanting, there being only 4) in the fore limb being shorter and placed, plantad and palmad with

regard to the other three. The sole and the dorsum of the foot in the hinder limb are at right angles with the leg; and the heel is large and projects backwards. The lumbar and dorsal vertebræ admit of but little movement; whereas the large iliac and ischiatic bones indicate the greater size of the muscles passing from them to the thighs, and the greater power of movement of the limbs upon the pelvis. The clavicles are present, though the coracoid parts of the scapulæ are small as they are in the Seal. The tail is long, thick and strong.

Muscles of Skin.

The *Platysma myoides*, in ORYCTEROPUS, was very strong and of great extent. In the middle of the neck it was thickest and narrowest. Traced forwards it expanded and became thinner as it approached the side of the head, and divided into two bands, of which one passed along the side of the lower jaw, and terminated in the thick part of the lower lip, reaching nearly to its margin, and served as a *depressor labii inferioris*. The other, or supra-maxillary band, broader than the infra-maxillary, covered the superior maxillary bone, and had extensive attachments to the lower margin of the orbit. Its lowermost fibres were continued forwards, as the *levator labii superioris et alæ nasi*, to the side of the snout, expanding in the upper lip and on the nostril, and serving to give tension to the lip and to dilate the nostril. The supra and infra-maxillary portions were connected, soon after their separation, by a broad band of fibres passing between them. (Pl. III.)

Traced backwards from the middle of the neck the platysma soon divided into two broad bands, of which one (a 'sternal' band) passed along the inferior surface of the sternum, to its hinder end, running parallel with the corresponding band of the opposite side. The other, or 'brachial,' band, extended down the fore part of the arm and expanded upon the fascia of the outer, or radial, side of the upper half of the forearm.

The fibres of the muscle crossed, to some extent, in the middle; some of the sternal fibres passing, behind the brachial fibres, to the supra-maxillary portion, and some of the brachial fibres crossing superficially to the sternal fibres, and reaching

the infra-maxillary portion. There was thus a direct continuity of fibres from the lower lip to the forearm; and the movements of the forearm might seem to have had an effect upon the lips and the nostril. This was however, doubtless, in great measure, prevented by the absence of any distinct sheath and by the coarse intermuscular tissue, as well as the muscular fibres themselves being continuous with the tissue of the skin on the one side, and with the subjacent cellular tissue on the other.

This extension of the platysma forwards and more especially downwards to the forearm is a good example of what we so frequently find and must always bear in mind in comparing the muscles in different animals, viz. that a structure which is muscular in one animal may be tendinous or fibrous or even areolar in another. These extensions of the platysma in the orycteropus are merely the result of a development into muscles of the fibrous or areolar tissue which usually constitutes the more or less well-defined connections of the muscle with the subcutaneous structures of the chest, arm, and forearm in man and other animals. In the terminal parts of the limbs certain muscles, more especially those of the lateral digits (the 1st and 5th, which, be it remarked, are those most frequently observed to fade or disappear altogether), are often, as in the Seal (p. 317), represented only by fibrous bands. The developmental differentiation has advanced no further in them.

In PHOCA the *Platysma* was scarcely discernible, being blended with the fibres of the *Panniculus carnosus* which was large, covering the whole of the back from the head to the sacrum. Its fibres met in the middle line, were for the most part tendinous near the middle line, and were closely connected with the tendinous fibres of the trapezius and with the ligamentum nuchæ. Extending laterally they were muscular, and formed a sheet of considerable thickness. They then passed over the sides of the trunk and terminated in tendinous fibres which were blended with the cellular tissue and skin of the under part of the chest and abdomen. The hindmost fibres covering the hinder part of the abdominal wall and crossing the origin of the pectorals, formed the outermost layer of the fold beneath which the knees are drawn up in the usual position of the animal. On the shoulders they were lost in the superficial fascia and skin, being closely connected with the pectorals in

the axillæ[1]. In the neck they covered the whole under surface, interlacing in the middle line, and closely connected with the trapezius and sterno-mastoid. Anteriorly, they passed over the occiput upon the vertex and superciliary regions, and were continued over the cartilaginous tube of the ear upon the face and into the lips.

The *Panniculus* in ORYCTEROPUS extended over the sides of the abdomen, the pelvis, buttock, and the outer sides of the thighs and knees. Its fibres were closely connected with those of the latissimus dorsi, obliquus ext. and the lower margin of the pectoralis major. (Pl. V.)

Between the infra and supra-maxillary portions of the platysma in ORYCT. was seen the *Buccinator*, passing from both the maxillæ and expanding upon the buccal mucous membrane; and its supra-maxillary portion was crossed by a delicate slip, the *Levator anguli oris*, passing from the side of the superior maxilla to the skin near the angle of the mouth. (Pl. III.)

Emerging from beneath the supra-maxillary portion of the platysma, just above the *Levator labii*, was a distinct strap-like muscle, representing perhaps the *Compressor narium*. It extended from the maxillary bone to the upper part of the snout and had the effect of moving the snout upwards, or forwards when the head was down: it may be called *Levator nasi*. (Pl. III.)

In PHOCA most of these muscles of the lips were strongly developed. The *Levator labii superioris et alæ nasi* was very large, passing from the margin of the orbit, above the supra-maxillary foramen, to the fore part of the upper lip where it invested the whisker bulbs. The *Compressor narium* was also large. Passing from over the bridge of the nose, where it was confluent with its fellow, and descending from the frontal bone it was spread out on the side of the nostril and blended with the *Levator labii*. The foremost fibres, covering the extremity of the nasal cartilages, passed obliquely backwards, crossing the others. *Levator anguli oris* passed from beneath the fore part of the orbit to the angle of the mouth. The *Levator labii*

[1] This connection representing the distinct slip from the panniculus, which in the rat and many other animals passes with the pectoral muscle, in the axilla, to the humerus.

superioris passed from beneath the supra-maxillary foramen into the margin of the lip. The *Depressor labii superioris* was of large size, passing from over the incisor teeth into the tissue about the whisker bulbs. Some of the fibres, distinct from the rest, ran inwards to the nostril. *Levator* and *Depressor labii inferioris* very small. (Pl. VI.)

It will be perceived therefore that in Orycteropus the facial muscles are much connected with the platysma, and their development has relation chiefly to the movements of the thick truncated snout; in Phoca they are more connected with the facial bones, and are directed more to the movements of the upper lip and its whiskers.

In both animals the *Orbicularis oris* was feeble; the *Orbicularis palpebrarum* and *Corrugator supercilii* presented nothing remarkable.

The muscles of the ear in the two animals presented a contrast corresponding with the difference in the size of the external ear. Thus,

In ORYCTEROPUS several large muscles passed to the well-developed cartilage and skin of the external ear. The *attrahens* arose (1) from the lower jaw just beneath the condyle, (2) from behind the margin of the orbit, and (3) from above the margin of the orbit, where it was connected with the orbicularis. The fibres from these sources converged to the under and fore part of the ear. The *Depressor* was a slip detached from the sterno-mastoid and traceable to the sternum. It ascended beneath the platysma to the lower part of the ear[1]. The *Retrahens* arose from the middle line of the nape of the neck. The hinder fibres passed from those of the opposite side at an acute angle, the middle more transversely, and the foremost were in contact with those of the following muscle. The fibres converged to the back of the ear. The *Attollens*, from the middle line over the hinder part of the head, passed to the upper surface of the ear. It terminated in the middle in a defined edge; but some of its foremost lateral fibres were con-

[1] The external jugular vein crossing the sterno-mastoid entered the angle between it and this muscle, passed beneath the latter and then descended in front of the clavicle, dipping into the subclavian vein in the triangular space between the clavicle and the subclavian muscle. (Pl. IV.)

tinued, above the ear, to the upper margin of the orbit, there blending with the orbicularis and the attrahens. (Pl. v.)

In PHOCA the tubular cartilage of the ear as it passed upwards to the external orifice in the skin was covered by the fibres of the panniculus which were slightly attached to it, and would serve to draw it backwards. There was also a distinct *attrahens* passing from the zygoma, above the glenoid cavity, upwards, to the external auditory tube near its outlet, and an *attollens* passing from over the orbit to the same part. These were, however, feeble. (Pl. VI.)

FORE LIMB.

Pectoralis major (ORYCT.) large, had no attachment to the clavicle, but arose from the whole of the front of the sternum, and from several costal cartilages behind the sternum. Its fore part was thick like the clavicular portion of the human pectoralis. Its hinder part was much thinner, and was continuous with the obliquus abdominis and the latissimus dorsi. The greater number of the fibres converged to the external bicipital ridge: some of the anterior portion joined the tendons of the biceps and the fore part of the deltoid, and were inserted with them into the tubercle of the radius; and some of the hindmost fibres, separating from those which ran to the humerus, passed to the forearm and were lost in the tissue between the fascia and the skin of the inner surface of the upper half of the forearm. (Pl. IV.)

In PHOCA the *Pectoralis major* covered nearly the whole of the under surface of the abdomen, chest, and hinder part of the neck, the fibres converging to the fore part of the axilla, and being inserted into the broad prominent ridge descending from the great tubercle of the humerus in front of the bicipital groove. It arose in two divisions. The first, the pectoralis proper, attached to the long episternum, the sternum, and two costal cartilages. The hinder part of this division formed a fascia expanding upon the forearm and carpus. The second division arose from the linea alba and the pubes, and also from the margin of the ilium, covering the fibres of the external

oblique which were seen running transversely between the iliac and the pubic portions[1]. (Pl. VI.)

Pectoralis minor (ORYCT.) small, flat, beneath pect. maj., from two costal cartilages, near the hinder part of the sternum, to the outer bicipital ridge.

Subclavius (ORYCT.) was a large muscle arising from the first and second costal cartilages and the adjacent part of the sternum beneath the pectoral. It ran outwards and was attached by a few fibres to the under surface of the outer part of the clavicle; but the greater part of it passed beneath the clavicle, over the coracoid and coraco-acromial ligament, on to the dorsum of the scapula where it was inserted into the fascia covering the supra-spinatus as well as into the margin of the acromion (Pl. IV.).—(PHOCA) thin from the margin of the sternum, opposite the 2nd, 3rd, and 4th ribs and inserted into edge of the 1st rib near the point corresponding with the insertion of the scalenus anticus in man. The artery of the fore limb crossed its insertion. It was in close contact with the scalenus; indeed some of its fibres joined that muscle. (Pl. VI.)

Latissimus dorsi (ORYCT.) arose from the six lower dorsal spines beneath the trapezius and from the lumbar fascia. It was also closely connected with the panniculus. Its foremost fibres were blended with those of the triceps cubiti arising from the angle of the scapula; and the rest of its fibres were inserted into the hinder bicipital ridge of the humerus. (Pl. V.) In PHOCA it was in two portions. One of these arose from the dorsal spines under the trapezius; it overlapped considerably the posterior angle of the scapula and the origin of the triceps, but was not connected with either. It passed with the teres, as usual, to the posterior bicipital ridge. The other portion arose from the lumbar fascia and two or three ribs. Its fibres did not take quite the direction of the former portion, but crossed beneath the pectoralis to be inserted beneath it into the anterior bicipital ridge[2]. (Pl. VI.)

[1] In Pteropus and in the Frog the pectoral extends over the surface of the abdomen to the pubes.

[2] I did not find that it extended so far upon the arm and forearm as Meckel describes. In a male subject in our dissecting-room lately, Mr Carver found the latissimus dorsi arising further forwards than usual (from the four lower ribs);

Trapezius in ORYCT. was disposed as in man, except that its upper part was covered by the retractor auris, and it was not attached to the clavicle, but only to the acromion and the spine of the scapula. In PHOCA the hinder fibres passed over the hinder part of the deltoid and were attached to the back part of the spine of the scapula: the middle fibres were partly confluent with those of the deltoid, and partly attached to the scapular spine: the foremost fibres passed over the scapula, parallel with and close to the deltoid, and were inserted, near the latter, into the outer tubercle of the humerus, and the ridge descending from it. Some of its fibres were in close contact with if not continuous with, those of the panniculus.

The Trapezius and the Deltoid may be regarded as one muscle often separated by the clavicle and the spine of the scapula. In many animals where the clavicle is absent their clavicular portions are continuous; and in the Seal their scapular portions are also to some extent continuous. They form, indeed, one of the divisions, or sectors, of a large, circular, more or less, continuous sheet which, in these and most other mammals, converges from the trunk upon the humeral segment of the limb and has its chief attachment to that segment; though it, or portions of it, may extend below the humerus and reach even to the carpus or tarsus and the digits. Peripherally, this sheet is attached to the various surrounding parts of the trunk, including the head, the sternum, and, it may be, the linea alba and pubes, the ribs, the pelvis, the lumbar, dorsal and cervical spinous processes. It is the chief agent in moving the limb upon the trunk. It may form an almost continuous circular sheet; or it may be, and usually is, split into three radiating segments, which constitute the following muscles: (1) Trapezius with the Cervico-humeral and Deltoid. (2) Pectoralis major and minor. (3) Latissimus dorsi. In the hind limb the radiating segments corresponding with these are composed of Glutæus, with Sartorius and Tensor vaginæ femoris, Gracilis and, perhaps, Psoas magnus.

A second or inner circle, enclosed by the preceding, radiates from the base of the scapula to the trunk and, sometimes, to the head. It consists of the Serratus magnus anticus, the Levator scapulæ, and the Rhomboidei. There is no correspondent to this circle in the hinder limb, the pelvis not being, like the scapula, moveable upon the trunk.

Cervico-humeral (ORYCT.) arose from the transverse process of the atlas and passed to the part of the acromion where it

and the foremost fibres (those arising from the 9th rib) passed, on the front of the biceps tendon, to the fore part of the bicipital groove. The same thing has been observed by others.

blends with the spine of the scapula, and was there inserted superficially to the trapezius. (Pl. IV.) In PHOCA it arose from the same point in two portions, of which one passed to the outer tubercle of the humerus near the trapezius, while the other passed to the anterior angle of the scapula, and overlapped the supra-spinatus[1]. (Pl. VI.)

Levator scapulæ (ORYCT. and PH.) from the 2nd, 3rd, 4th, and 5th cervical transverse processes to the base of the scapula above the spine, and to the fascia covering the supra-spinatus. The hinder fibres were continuous with those of the next muscle, and inserted with them into the inner surface of the base of the scapula. (Pl. V. VI.)

Serratus magnus (ORYCT. and PH.) disposed much as in man, except that it formed a continuous sheet with the levator scapulæ.

Rhomboideus minor (ORYCT. and PH.), a long muscle from the occipital crest, and the mesial cervical ligament to the base of the scapula near the spine. *Rhomboideus major* much as in man. (Pl. V. VI.)

Deltoid (ORYCT.) consisted of two parts—one, arising broad and muscular from the anterior edge of the outer part of the clavicle, descended, tapering, along the front of the arm, joined the biceps after being separated from it by the pectorals, and was inserted with it into the tubercle of the radius. The other part passed from the outer margin of the acromion and the spine of the scapula, as usual, to the rough ridge on the outer side of the humerus. (Pl. IV.) In PHOCA it arose from part of the supra-scapular fossa, in the place of the infra-spinatus, and was inserted as usual. Some of its fibres were, as above said, confluent with those of the trapezius. (Pl. VI.)

Supra-spinatus (ORYCT.). Its tendon was inserted some way down beneath the great tubercle of the humerus occupying a groove which was external to that for the biceps, and looked like a second bicipital groove; (PH.) disposed as usual.

[1] It did not extend to the mastoid process of the temporal, though Meckel (*Vergleichende Anatomie*, III. 476) describes it as so doing, and regards it as representing the cleido-mastoid and the clavicular part of the trapezius. It would seem more likely to be a portion detached from the trapezius and attached to the large transverse process of the atlas.

Infra-spinatus and *Teres minor* (ORYCT.) nothing particular; in PH. very small, and almost confined to the under surface of the scapular spine.

Teres major (ORYCT.) arose from the inner surface of the angle of the scapula, the whole of the posterior margin being occupied by the triceps: (PH.) from the external surface of the angle of the scapula. It was attached to the humerus, as usual, in both.

Sub-scapularis (ORYCT.) from the part of the inner surface of the scapula not occupied by the teres and from the wide post-coracoid ligament. Its tendon passed on the outside of the capsule of the shoulder-joint to the inner tubercle of the humerus; (PH.) as usual.

Coraco-brachialis (ORYCT.) from the coracoid and post-coracoid ligament[1] to the inner surface of the humerus as low as the supra-condyloid hole; (PH.) absent, as well as the pectoralis minor.

Biceps (ORYCT.) had only one origin, viz., from the middle of the fore part of the coracoid process. Its tendon passed directly *over* the capsule of the shoulder-joint, between the tubercles of the humerus, and was inserted into the tubercle of the radius, being previously joined by the clavicular portion of the deltoid. It had no connection with the fascia or muscles of the forearm; but a few of its fibres passed with those of the brachialis anticus to the ulna (Pl. IV.). (PH.) From the process (the short coracoid) projecting over the glenoid cavity. Its tendon did not pass through the shoulder-joint; though at one small point it was exposed to the synovial cavity. It was attached to the tubercle of the radius, not sending any fibres to the ulna. (Pl. VI.)

The more constant origin of the biceps seems to be from the coracoid. In the Frog and the Bird it has no connection with the scapula. Where the coracoid is small there is usually only one tendon. In the Dog I found a slight furrow in this tendon suggestive of a division into two. When the coracoid runs out into a process of any considerable length the tendon is divided into two,

[1] The post-coracoid notch is very wide in Orycteropus, and occupied by a ligament (like that occupying the obturator hole) between the sub-scapularis and the supra-spinatus.

as in man. The biceps may also, as in the Bird, derive a slip from the humerus, or from a portion of the external circular muscle described above (p. 298) as moving the fore limb upon the trunk. Thus in Orycteropus the clavicular part of the deltoid joins the biceps.

Brachialis anticus arose, in both animals, from the outer side of the shaft of the humerus behind the ridge descending from the outer tubercle, there being, as seems commonly the case, no portion corresponding with that which in man descends from the inner side of the insertion of the deltoid. It passed to the coronoid process of the ulna. In Orycteropus it received some fibres from the biceps; and in the Seal a bundle of its foremost fibres passed to the biceps, and were inserted with it into the tubercle of the radius.

Triceps extensor cubiti (ORYCT.) arose, as in man, by two portions from the hinder surface of the humerus and from the posterior costa of the scapula, just behind the glenoid cavity, and, further, by two additional divisions, from the whole of the posterior costa. Of these one was very large, occupying the greater part of the costa, while the other was smaller and near the angle and confluent, to some extent, with the latissimus dorsi. Some of the fibres of the latissimus dorsi also ran parallel with and close to, or conjoined with, those of the humeral portion of the triceps on the inner side of the arm. There were thus three divisions from the posterior costa of the scapula. They were more or less united; but it could be seen that the middle and largest passed over the end of the olecranon separated from its smooth surface by a bursa, as in man, and was inserted into the rough ridge just beyond it: the hindmost division, from the angle of the scapula, was inserted on the inner side of the olecranon; and the post-glenoid division was inserted on the outer side of the olecranon. The division of the muscle arising from the humerus (the *post brachialis* as it might be called) was distinct from the scapular part, and was inserted into the upper surface of the olecranon, between the bursa just mentioned and the articular facet: an additional small portion (an *anconeus*[1]

[1] This origin is found not unfrequently in the human subject and has been named *Epitrochleo-anconeus*. See p. 106, of this Vol.

internus) passed from just above the inner condyle to the inner side of the olecranon. (Pl. v.) In PHOCA the muscle arose by four divisions, two from the humerus and two from the scapula: one from the outer surface of the posterior angle of the scapula, distinct from the trapezius, passed over the point of the olecranon sending a few fibres to it, and ran along the inferior edge of the forearm and paddle to the second phalanx of the 5th digit, serving to expand the paddle by separating the 5th and with it the other digits from the 1st: a second passed from the outer surface of the posterior costa of the scapula, behind the glenoid cavity, to the lower, or distant, part of the long posterior surface of the olecranon[1]: a third passed from the posterior and outer surface of the humerus, behind the outer tubercle, to the upper projecting angle and adjacent part of the hinder surface of the olecranon: a fourth passed from the possterior surface of the humerus, behind the external supracondyloid ridge, to the rough upper surface of the olecranon behind the articular surface. These four portions were all more or less blended at their insertion. (Pl. VI.)

No distinct *anconeus externus* in either animal.

Pronator radii teres was disposed in both as in man, except that it had no origin from the ulna. *Pronator quadratus* was small.

Flexor carpi radialis arose, in both, from the inner condyle of the humerus. In ORYCT. it was attached to the head of the 2nd (index) metacarpal. A small sesamoid bone was included in it where it passed over the projecting scaphoid close to the metacarpal. It sent a slip transversely, or with a slight inclination backwards, to the lower margin of the radius. (Pl. IV.) In PHOCA it was inserted chiefly into the base of the 1st metacarpal. Some fibres of its tendon were attached to the scaphoid; and a slip passed on to the 2nd metacarpal. (Pl. VI.)

This attachment to the 1st metacarpal in the Seal, and it was the same with the radial extensor, is favourable to the movement of the paddle, inasmuch as the osseous components of the 1st digit are the longest, largest, and most fixed of the series.

[1] This is very broad and easily divisible into two portions, and is described as two by Meckel (*l.c.* 528). It is rather surprising that he makes no mention of the extension to the 5th digit of the portion coming from the angle of the scapula.

Flexor carpi ulnaris (ORYCT.) as in man.—In PHOCA it arose exclusively from the inner and back part of the large olecranon and the surface of the ulna. It had a slight insertion into the pisiform bone; but the greater part of its fibres terminated in two broad tendons which passed one on the superficial the other on the deep aspect of the flexor tendons. Of these the superficial crossed, beneath the palmaris longus, to the radial side of the wrist, and was blended with the tendon representing the flexor brevis pollicis: it thus corresponds with the annular ligament of man, some fibres of which are derived from the fl. c. u. The deeper tendon expanded upon the palmar aspect of the carpal bones.

Palmaris longus in ORYCT. was merged in the flexor digitorum sublimis.—In PHOCA it arose not from the inner condyle of the humerus but from the inner side of the olecranon where some of its fibres were continuous with those of the post-glenoid portion of the triceps. It expanded into the palmar fascia and sent a division to each of the three middle digits. These were continuous with the sheaths of the flexor tendons by their superficial fibres, and by their deeper fibres were connected with the tendons of the flexor sublimis. A strong process of its palmar expansion passed outwards to the margin of the radius, carpus and pollex. (Pl. VI.)

Flexor digitorum sublimis (ORYCT.) comparatively small and imbedded in the much larger fl. dig. profundus. It arose from the internal condyle of the humerus and expanded at the wrist into a broad tendon which was superficial to the annular ligament, was connected with the subcutaneous cellular tissue and was the only representative of the palmar fascia. From this expansion a tendon passed to each of the four digits. Over the metacarpo-phalangeal joints each of these tendons sent off a superficial expansion which blended with the sheath and cross-bands of the deep flexor tendon; while the deeper portion of the tendon split into two, which separated, embraced the deep flexor, and passed behind it to be inserted into the base and sides of the second phalanx. (Pl. IV.) In PHOCA it was a very thin delicate muscle, arising from a thin fascia on the surface of the flexor profundus. It terminated in three delicate tendons,

which passed to the three middle digits and were disposed as usual. They received a few fibres from the palmaris longus.

Flexor digitorum profundus (ORYCT.) very large, arising from the inner condyle, the interosseous ligament, and a considerable part of the palmar surface of the radius and ulna, so occupying the place of the fl. long. pollicis in man and much of that of the fl. subl. dig., and forming a channel in which the latter muscle was situated. Its numerous fibres ended in a broad tendon which passed under the thick annular ligament, separated from it and from the subjacent bones by loose cellular tissue, and divided into four tendons inserted into the terminal phalanges of the four digits. Each of these was divided by a longitudinal slit near its insertion. (Pl. III.) In PHOCA its distribution was much the same; except that the greater proportion of the fibres arising from the radius passed to the 1st digit, constituting a representative of the *flexor longus pollicis*, which did not exist as a distinct muscle.

The typically complete arrangement of the long flexors of the digits appears to be, as we find it in man, in three layers superimposed upon one another, viz. a superficial layer, consisting of the *palmaris longus*, which forms the palmar fascia, and is connected with the sheaths of the deeper strata and with the fibrous tissue of the cutis; a middle layer, consisting of the *flexor sublimis digitorum*, which passes to the 2nd phalanges of the digits; and a deep layer, consisting of the *flexor profundus digitorum* and the *flexor longus pollicis*, when it is present, which pass to the terminal phalanges. Of these the last, or deepest, layer is the most constant, though it sometimes fails to pass to the first digit. The other two vary a good deal in the degree of their development, being sometimes very small, or more or less imperfect, or blended, as in Orycteropus, or partially united, as in Phoca; or the middle layer may be blended with the deepest layer. Often they fail to extend to the 1st and the 5th digits, as in Phoca, or to one of them. The comparison of them with the corresponding muscles in the hind limb is interesting (p. 316).

Lumbricales, in ORYCT., passed from the palmar surface of the broad tendon of the preceding muscle to the radial sides of the four digits.—In PHOCA they were absent.

Flexor minimi digiti. In PHOCA there was a distinct tendon passing from the internal condyle of the humerus to the unciform bone, where it was blended with tendinous fibres (fl.

brevis minimi digiti) passing to the second phalanx of the 5th digit.

Abductor minimi digiti (ORYCT.) from ulnar side of metacarpal to ulnar side of first phalanx.

Interossei (ORYCT.), three *palmar*—one on the ulnar side of 2nd digit and one on the radial side of each of the 4th and 5th digits. They were all attached at the bases of the metacarpals; and the origin of that of the 5th digit extended over the others. There were four *dorsal* attached to the sides of the metacarpals, though still rather on the palmar than the dorsal aspects; one passed to the radial side of each of the 2nd and 3rd digits and one to the ulnar side of each of the 3rd and 4th digits. There was therefore an adductor and an abductor of each digit. In PHOCA there was also an abductor and adductor of each digit; but all were on the palmar rather than the dorsal aspect.

The typical arrangement of these deep muscles (interossei, adductors and abductors) I think is as follows: a muscular belly lies upon each side of each metacarpal, the two bellies being approximated, or united, on the palmar surface of the metacarpal at the middle and proximal parts. Towards the distal part they diverge; and each is attached to the side of the sesamoid body, so constituting a short flexor, while some of the fibres pass upon the sides and dorsal aspect of the phalanges. These have the effect of abducting or adducting, as the case may be, and, to a certain extent, of extending the digit[1]. In the instance of the 1st and also in that of the 5th digit, but of the 1st more particularly, the sesamoidal or flexor portions are more distinct from the phalangeal or abductor and adductor portions than in the remaining digits. Hence we find, not unfrequently, in the case of one or other, or both, of these digits an abductor and an adductor separate from the short flexor. In the remaining digits, indeed (and it may be so in the first and fifth), the sesamoidal portions are often wanting or nearly so. Moreover, some of the fibres passing to the phalanges may, and often do, extend further upon the palmar surface of the limb, gaining attachment to (*i.e.* origin from) the carpals or to some other of the metacarpals besides their own. This is particularly the case with the muscles passing to the ulnar side of the 1st and to the radial side of the 5th digit. These two not unfrequently meet and so cover the others, and their efficiency in approximating the two marginal digits is thus materially increased. The muscles passing to the radial side of the 4th digit and to the

[1] This arrangement is very clearly seen in the Rabbit, the flexor portions passing to the sesamoid bones being distinct from the abductor and adductor portions passing to the sides and dorsum of the phalanges.

ulnar side of the 2nd often do the same though to a less extent. The others, that is, those passing to the ulnar sides of the 3rd and 4th and to the radial sides of the 2nd and 3rd digits, extend somewhat upon the dorsal aspects of their respective metacarpals and may acquire an attachment to the adjacent metacarpals. In other words, those muscles which pass upon the palmar aspect, and may be supposed to be associated with the flexor muscles in their action, have the effect of approximating the digits towards a line corresponding with the axis of the 3rd digit; whereas the muscles which pass upon the dorsal surface, and may be supposed to be associated with the extensors in their action, have the effect of abducting the digits from that line. Thus the palmar interossei cooperate with the flexors in the combined movements of flexion and approximation of the digits, while the dorsal interossei cooperate with the extensors in the combined movements of extension and separation of the digits; and we thus find a reason for that arrangement of the interossei, which is very regular and which is very marked in the human hand where the lateral movements are free, though it is less marked in most of the lower animals. Indeed, in many of the latter the interossei are limited to the palmar aspect or extend very little towards the dorsum.

Supinator longus arose in both from above the internal supra-condyloid ridge. In ORYCT. it formed a prominent ridge at the bend of the elbow; and its tendon was partly expanded upon the back of the carpus and metacarpus. (Pl. III.) The deeper fibres of the tendon were attached to the ridges of the radius projecting between the extensor tendons; and some of them were inserted into the trapezium. In PHOCA it was inserted into the projecting upper margin of the radius near the wrist[1].

Supinator brevis in both, as in man, but larger, and extending further down the radius.

Extensor carpi radialis, one muscle arising from the external supra-condyloid ridge beneath the preceding. In ORYCT. it was inserted into the radial side of the 3rd metacarpal in the position of the ext. c. r. brevior of man.—In PHOCA it divided as it passed over the wrist into two tendons of unequal size. Of these the smaller was attached to the radial side of the 1st metacarpal, and the larger to the radial side of the 2nd metacarpal. (Pl. VI.)

[1] There was no trace of the second deeper portion of this muscle described by Meckel (*l. c.* 585).

Extensor carpi ulnaris (ORYCT.), from the outer condyle, from the wide outer surface of the olecranon and from the shaft of the ulna. Its tendon divided to be inserted into the 4th and 5th metacarpals, the larger portion going to the former.—In PHOCA it had a slight origin from the olecranon, in addition to that from the outer condyle, and was inserted into the ulnar margin of the 5th metacarpal, serving to adduct this digit and so to expand the paddle.

Extensor communis digitorum (ORYCT.) consisted of four tendons derived from two bundles of muscle which arose, close together, from the outer condyle of the humerus. The tendons were joined at the wrist and passed to the four digits, each sending the deeper portion of its substance to the base of the second phalanx while the more superficial part ran to the base of the terminal phalanx. In PHOCA there were two muscles arising from the external supra-condyloid ridge, one above the other. Their tendons passed through distinct grooves on the back of the radius; and each supplied the outer four toes. The one (*extensor communis digitorum*) arose rather the higher, passed as one tendon over the carpus, and expanded web-like on the metacarpus; and its four tendons ran along the radial side of the back of the phalanges; so that it served to adduct the several digits to the pollex as well as to extend them. The other (*extensor secundus digitorum*) arising lower than, and lying on the ulnar side of, the communis, divided into four tendons about the middle of the forearm. These crossed beneath the tendons of the primus (two of them at least), and ran along the ulnar side of the back of the phalanges; so that they served to abduct the digits from the pollex as well as to extend them. The tendon to the 5th digit was larger than the others. (Pl. VI.)

Extensor annularis in ORYCT. arose from the outer condyle, external to the ext. communis. It had a strong tendon which ran beneath the tendon of ext. c., sent off a band to the base of the 1st phalanx of the 4th digit and ran on to the ulnar side of the base of the 2nd phalanx, close to the insertion of the deeper portion of the tendon of the ext. c.

Extensor minimi digiti (ORYCT.) arose from the outer con-

dyle external to the preceding and was inserted, much in the same way as it, into the ulnar side of the 1st and 2nd phalanges of the outer two digits.

Extensor indicis (ORYCT.), from the surface of the ulna beneath the ext. communis, divided into two tendons, of which one ran to the ulnar side of the first phalanx of the index or 2nd digit, and the other to the radial side of the first phalanx of the middle or 3rd digit.

Extensor ossis metacarpi pollicis (ORYCT.), a large muscle arising from the back of the radius and ulna, in the usual position of the extensors of the pollex in man, and passing superficially to the ext. c. radialis to be inserted into the trapezium which is the only rudiment of the pollex and which lies on the radial side of the base of the index metacarpal. In PHOCA it arose from the outer surface of the olecranon, passed in a deep groove on the edge of the radius, and was inserted into the radial margin of the proximal end of the 1st metacarpal, distinct from and on the radial side of the tendon of the ext. c. radialis.

Extensor primi internodii pollicis (ORYCT.), absent. In PHOCA it arose from the olecranon beneath the preceding, passed in a groove of the radius, close to but distinct from the extensor digitorum communis, and was inserted into the back of the first phalanx of the pollex.

Extensor secundi internodii pollicis, absent in both.

The typical arrangement of the extensors of the digits is in three sets of muscles. The first set is represented by the *Extensor communis digitorum* arising from the radial side of the limb and passing over the backs of the phalanges to the terminal phalanges of the four outer digits. The tendons lie on the middle of the digits and extend on their radial and partly also on their ulnar side. The second set is represented by the *Extensor secundus* of the Seal and by the separate extensors of several digits in Orycteropus and other animals, and the extensor minimi digiti of man[1]. These lie on the ulnar side of the common extensor; and their tendons pass more

[1] A small muscle lately pointed out to me by Mr Carver in our dissecting room, in the body of an adult man, was probably also a representative of this extensor secundus. It arose as a flat fleshy belly from the lower margin of the radius, on the ulnar side of the groove for the extensor of the terminal phalanx of the pollex, and ended in a thin tendon which joined the ulnar side of the extensor tendon of the 3rd digit.

on the ulnar side of the phalanges. Such of them as cross the tendons of the common extensor pass beneath them in so doing. This second set appears to correspond with the extensor brevis digitorum pedis. The third set consists of the muscles which pass from the ulnar side obliquely across, beneath the two preceding sets, to the first and second digits, commonly to the first only, on the radial side. This set appears to correspond with the extensor longus pollicis and some of the peronei in the hind limb.

The extensor tendons differ from the flexors in passing to the lateral as well as the median parts of the phalanges, which enables them to act as abductors and adductors as well as flexors of the digits; and it may be remarked that these lateral movements are associated with extension rather than flexion, attain their maximum in the extended and are at their minimum in the bent position. This is very obvious in the human hand.

HIND LIMB.

Psoas magnus (ORYCT.) much as in man. In PHOCA it arose from the lumbar transverse processes and last rib. The greater part of its fibres were inserted into the brim of the pelvis in front of the hip-joint; some of them were continued down the inner side of the thigh, and inserted into the large rough supracondyloid ridge. These were chiefly the fibres that arise lowest down, and which had therefore a nearly horizontal course[1].

There is no distinct internal trochanter in the Seal, and none of the fibres either of the psoas or iliacus internus are inserted in that situation.

Psoas parvus in each was large, arose from the bodies of the lumbar vertebræ and, slightly, from the edge of the hindmost rib, and was inserted into a projecting process of the pubes internal to the psoas magnus.

Iliacus internus (ORYCT.) extended lower down the femur than in man. In PHOCA it was represented only by a few fibres passing from the anterior surface of the ilium (internal to the attachment of the large quadratus lumborum which occupies almost all this surface of the ilium), and joining the psoas in the thigh[2].

[1] It may be a question whether these fibres, arising low down and passing to the femur, appertain to the psoas or to the iliacus. In the Rabbit a muscular mass arising from the same part (the body of the last lumbar vertebra) is distinct from the psoas, but joined with the remainder of the iliacus which arises from the outer surface of the ilium.

[2] Meckel describes the iliacus internus in the Seal. Duvernoy appears not to have found it; and indeed its existence as a separate muscle may be ques-

Gracilis (ORYCT.) very broad from the symphysis and adjacent part of the pubes, over the inner side of the thigh, expanding upon the inner side of the knee, leg, ankle, and foot. Its hinder margin, united with the semimembranosus, formed a thick band attached to the ligaments beneath the internal malleolus. (Pl. IV.) In PHOCA it was also very broad and covered the symphysis pubis, being continuous with the muscle of the opposite side. The chief direction of its fibres was transverse; but they radiated as they approached the leg, the upper fibres ascending nearly to the knee, and the lower fibres descending to the inner ankle, covering the interval between the internal malleolus and the os calcis, and extending as a fascial expansion over the plantar fascia and muscles. Many of its fibres were inserted at right angles, or nearly so, into a tendon which ran along its fore part parallel with the tibia. This tendon passing the inner ankle, was continued, on the plantar aspect of the hallux, into a tendon which represented the flexor brevis and the adductor hallucis and was inserted with them into the base of the first phalanx of the hallux; some of its fibres extending to the distal end of that phalanx. In one foot of this Seal the hinder margin of the gracilis tendon was also thick, and formed or contributed to form the superficial flexor tendon of the fifth digit.

Pectineus (ORYCT.) from the margin of the pubes, internal to the gracilis, over the inner side of the thigh and knee in front of the gracilis.

Adductores (ORYCT.), a considerable mass in three divisions, *magnus*, *longus*, and *brevis*. They arose from the lower part of the circumference of the obturator hole and were inserted into the linea aspera. Many of the fibres of the two sides met beneath the pubes behind the gracilis. In PHOCA the muscles of the front of the abdomen overhung the knee; and when these were removed a wide deep chasm was exposed between the long pubes, on the one side, and the thigh, knee, and leg, on the other. This chasm was crossed behind by a large muscle

tioned. Meckel describes the psoas parvus as being larger and the psoas magnus as smaller than I have represented them. In other respects his account coincides with that in the text. *Vergl. Anat.* III. 591.

passing from the side of the symphysis pubis to the front of the upper part of the leg and knee beneath the gracilis. It may perhaps be regarded as an *Adductor magnus*. At the fore or narrow part of the chasm were two other adductors passing from the rough processes on the front of the pubes, internal to the psoas parvus, to the hinder surface of the femur. (There is no linea aspera as well as no lesser trochanter in this animal.)

Sartorius (ORYCT.) small, had no connection with the ilium but arose from the hindmost rib, just external to the psoas, passed under the crural arch, and sent some fibres in company with the pectineus, over the knee. The greater part of its fibres, however, were lost in a tendinous expansion covering the vastus internus, and descending between it and the adductors to the linea aspera. In PHOCA it passed from just beneath the anterior spine of the ilium to the upper surface of the patella.

Quadriceps (ORYCT.) arose as in man. The tendo patellæ was broad and inserted into the tubercle projecting from the line of confluence of the tibia and fibula as well as into the tuber tibiæ. In PHOCA the muscle was large and attached to the front of the ilium above the hip-joint, also to a rough surface which seems to represent the anterior spine of the ilium, as well as to the femur.

BUTTOCK AND BACK OF HINDER LIMB.

Glutæus maximus (ORYCT.), a very broad and strong muscle arising from the whole of the crest of the ilium as well as from the sacral and several of the caudal spines. It almost enveloped the thigh. Its foremost fibres which might perhaps be called *tensor vaginæ femoris*, arising from the lower margin of the ilium beneath the ant. sup. spine; passed on to the fore and inner part of the thigh. The middle portion of the muscle was spread out over the outer side of the thigh, the knee, and the leg, reaching nearly to the heel. The hindermost fibres wound beneath those in front of them, giving a thick margin to the muscle, and reached the hinder and inner part of the thigh,

knee and leg. All these widely disposed and strong fibres were inserted into the various parts of the fascia of the thigh, knee and leg, and, as I have said, nearly ensheathed the limb. The deeper fibres of its middle part were in great measure inserted, as in man, into the projecting ridge on the outer side of the shaft of the femur; while some of them passed into the fascia covering the vastus externus, and so formed a stratum beneath the more superficial layer of the muscle. (Pl. V.)

Thus the glutæus acts as a powerful retractor of the whole limb, of the leg and thigh at least, and contributes to strengthen the backward movement of the foot in scrapping. In PHOCA it arose from the back of the crest of the ilium, the sacral spines, and the sacro-iliac ligaments, and was attached to the trochanter and the external supra-condyloid ridge of the femur, while its lower part expanded over the knee-joint. Some of its fibres were continuous with those of the vastus externus. (Pl. VI.)

Glutæus medius (ORYCT.) from the outer surface of the ilium, beneath its crest, to the broad truncated upper surface of the trochanter. In PHOCA it was small from the hinder and under surface of the ilium to the top of the trochanter.

Glutæus minimus (ORYCT.) scarcely distinguishable from the preceding, In PHOCA it was large, passing from the concave hinder surface of the ilium to the fore part of the great trochanter.

Pyriformis, in both, as in man. *Obturatores*, large. *Gemelli* were disposed in ORYCT. as in man, but were scarcely distinguishable from the obturators in PHOCA. *Quadratus femoris*, not a distinct muscle in either.

Biceps flexor cruris (ORYCT.) consisted of one portion only, passing from the posterior inferior spine of the ilium, the ilio-sacral ligament, and the lateral part of the sacrum, to the lower part of the back of the leg, where it blended with the tendo Achillis and was inserted with it into the os calcis. (Pl. IV.) In PHOCA it consisted of two portions—(1), arising from the tuber ischii radiated into a broad muscle, the thin tendon of which was spread out over the fibula and fore part of the leg, reaching as low as the ankle; (2), a muscular strap from the under surface of the sacro-iliac ligament and sacrum crossed deeper than the

first portion and passed down to the outer malleolus and the sheaths of the extensor tendons of the foot[1].

Semimembranosus (ORYCT.) from the broad outer surface of the tuber ischii and the side of the tail to the upper part of the inner side of the leg.

Semitendinosus (ORYCT.) arising from the tuber ischii above the semimembranosus, crossed the latter at an acute angle, and descended beneath it to the inner side of the leg. Its lower margin was attached strongly to the ligaments behind the inner malleolus.

In PHOCA I could not distinguish between these two muscles in any part of their course. They arose from the sides of the three foremost caudal vertebræ, their fibres meeting those of the opposite side above the tail. They formed a broad oblong muscle, the tendon of which was expanded over the upper half of the tibia.

Poplitæus, in both, large and disposed as in man.

Gastrocnemius (ORYCT.) had three heads: (1) from the outer condyle of the femur with a sesamoid bone in its tendon; (2) from the inner condyle of the femur; (3) from the head of the fibula by a thin tendon. It formed a broad muscle covering the back of the leg; and its chief insertion was into the projecting point of the os calcis. The greater number of the fibres which arose from the fibula crossed beneath the rest of the muscle, and were inserted into the fascia at the back of the leg and the side of the tibia. Those fibres which formed the innermost part of the outer head and so corresponded with the *Plantaris* of man were placed deeper than the rest of that belly in the leg; and the greater number of them crossed behind it to its inner side, passed by the inner side of the tendo Achillis, expanded upon the extremity of the heel-bone covering the insertion of the tendo Achillis into it, and were continued into the plantar fascia. This plantar fascia was disposed much as in man, and was connected with the sheath of the flexor tendons, and so with the heads of the metatarsal bones and the

[1] The continuation of the tendinous fibres of the biceps into the sacro-sciatic ligament of man is a representative of this second origin of the muscle in the Seal, and of the similar origin in Orycteropus.

phalanges. The deeper portions of each division, however, except in the case of that to the pollex, split and passed on either side of the deep flexor tendon; (just as do the divisions of the short flexor in man which they no doubt represent) to be inserted into the base of the second phalanx. It may be added, that having passed to the upper surface of the tendon, in each instance, they united, thus quite embracing it, and again separated.

In PHOCA the *Gastrocnemius* arose as usual from the condyles of the femur and the inner margin of the upper part of the tibia, and had no connection with the fibula. Its tendo Achillis was inserted into the heel-bone. The inner and deeper portion of the outer head formed the *Plantaris*. This was a distinct muscle beneath the gastrocnemius. Its tendon passed over the heel on the inner side of the tendo Achillis and was continued into the sole, where it formed a fascial expansion beneath that of the gracilis, and closely connected with the expansion of the flexor digitorum. The greater part of it, however, was, on the left side, continued as the superficial flexor tendon of the 4th and 5th digits. On the right side it formed the superficial flexor of the 4th digit only, the superficial flexor of the 5th digit, on this side, being derived from the gracilis. (Pl. VI.)

The disposition of the plantaris in these animals, and especially in Orycteropus, indicates that it is in them the homologue of the plantaris, plantar fascia and flexor digitorum brevis of man and that it, and therefore these three, may be regarded as serially homologous with the palmaris, the palmar fascia, and the flexor digitorum sublimis of the fore limb. The tendency of the latter muscle to disappear, as observed in these animals and especially in the Seal, is in harmony with the more or less complete absence of the muscular fibres of the flexor digitorum brevis; and its close connection with the flexor profundus in the Seal is in interesting harmony with those offsets of the flexor digitorum pedis in that animal (see below), which represent parts of the flexor brevis.

Tibialis posticus (ORYCT.) from the back of the tibia and the back of the head of the fibula. It descended in two tendons on the inner side of the tibia. Of these the superficial, from the tibial part of the muscle, sent a slip to the flexor digitorum, and another to the plantar fascia, and was continued along the

inner side of the navicular and cuneiform bones to the inner side of the head of the first (hallux) metacarpal, sending a slip on to the inner side of the base of the first phalanx. The deeper tendon, from the fibular part of the muscle, was inserted into the hinder part of the scaphoid bone. (Pl. IV.) In PHOCA it arose from the interosseous ligament and the tibia, beneath the flexor digitorum. It was inserted (1) into the scaphoid; (2), by a distinct slip, into the inner side of the proximal part of the 1st metacarpal; (3) a considerable portion of its tendon extended into the ligaments under the tarsus and into the tendinous structure which represents the short muscles of the hallux. (Pl. VI.)

Flexor digitorum (ORYCT.) large from the head and back part of the fibula, in the place of the fl. long. poll. of man, from the deep interosseous space and the inner edge of the tibia by an expansion covering the tibialis posticus. It passed beneath the annular ligament, formed a broad thick tendon in the sole, which divided into five tendons passing to the terminal phalanges of the five digits, each presenting, as in the case of the fl. dig. prof. of the fore limb, a longitudinal slit previous to its insertion.

In PHOCA the *Flexor digitorum* descended the back of the leg in two bellies, one occupying the position of the flexor longus pollicis of man and arising from the back of the fibula, and the other that of the flexor digitorum and arising from the back of the tibia and also of the fibula, so covering the tibialis posticus. The former was much the larger, and its tendon passed over the groove in the backwardly projecting astragalus. The tendon of the latter portion accompanied that of the tibialis posticus behind the inner malleolus. The two tendons united into a broad flat band from which two tendons passed to each of the digits except the 5th. These tendons stood in the relation of superficial and deep flexor tendons. The superficial tendons were connected with the sheaths; and their deeper or upper strata passing in the sheaths, divided to give passage to the deep flexor tendons, were continued along the plantar surface of the first phalanges between the deep flexor and the phalanges, and were inserted into the base of the second phalanges.

In the case of the pollex the superficial tendon did not divide as in the other toes, but was inserted along the fibular side of the 1st phalanx, the prolongation of the tendinous representative of the flexor brevis pollicis being continued along the plantar surface of the phalanx between it and the deep flexor. The tendons of each muscle (fl. l. p. and fl. dig.) contributed some fibres to each of the tendons (with the exception presently to be mentioned), but the deep tendons were derived mainly from the flexor longus pollicis, the flexor digitorum being distributed chiefly to the superficial tendons. The superficial tendon of the 4th digit was in one foot, and that of the 5th in both, derived from the plantaris.

The typically complete arrangement of these flexors of the digits appears to be in three layers similar to and homologous with those of the corresponding muscles in the fore limb (p. 304). Thus the superficial layer consists of the *plantaris*, which forms the plantar fascia and is connected with the sheaths of the tendons of the deeper layers and with the fibrous tissue of the cutis. The middle layer consists of the *flexor brevis digitorum*, which passes to the second phalanges of the digits. The deepest layer consists of the *flexor longus digitorum* and *flexor longus pollicis*; these two, as in the fore limb, being rarely separate except in man; and even in him they are not completely separate, inasmuch as they are connected by a tendinous slip, the reminder and representative of the closer union in other animals. Moreover, the two superficial layers are variable as to the distinctness of their development. The middle layer often does not extend beyond the region of the foot. Often it is more or less blended with (it might be expressed arises from) the deepest, or, as in Orycteropus, with the superficial layer, or, as in Phoca, with both the deep and the superficial layers; and one or both of the superficial layers often fail to pass to certain of the digits, more particularly to the 1st or the 5th or to both. In Phoca, as we have seen, they do not pass to the 5th and pass to one side only of the 1st digit[1]. The continuity between the crural and pedal parts of the superficial layer, though interrupted in man at the heel, causing a division into plantaris muscle with tendon and plantar fascia, is commonly maintained in other mammals. The rule of the perforating relation of the tendons of the two deeper layers is observed with remarkable constancy in both limbs.

[1] It will be observed that in Phoca the components of the middle layer arise in both fore and hind limbs chiefly from the deep layer.

An interesting illustration of the homology of the flexor sublimis in the fore limb with the flexor brevis in the hind limb is presented in the Rabbit by the fact that one part of the former, that to the 5th digit, ascends no further than the carpus, where it arises as a fleshy belly from the sheath of the tendons.

Lumbricales (ORYCT.) from between the divisions of the flexor tendons to the radial sides of the phalanges;—absent in PHOCA.

Accessorius (ORYCT.) represented by a tendinous band passing from the outer side of the os calcis and joining the broad tendon of flex. dig. before its division. In PHOCA it was a considerable fleshy mass passing from beneath the groove of the peroneus longus to the tendon of the plantaris.

Abductor and Flexor brevis hallucis not present in either, or represented only by tendinous structure. The abduction of the hallux was effected to a greater or less extent by the tibiales muscles.

Adductor hallucis (ORYCT.) from the head of the middle metatarsal to the outer side of the first phalanx of the hallux; in PHOCA represented only by tendinous structure.

Adductor minimi digiti (ORYCT.) from the middle metatarsal near preceding muscle to inner side of first phalanx; absent in PHOCA.

Abductor minimi digiti (ORYCT.) as in man; absent in PHOCA. The abduction of this digit was in both effected mainly by the peronei.

Interossei were, in both, situated upon the two sides of the three middle metatarsals, and passing to the sides of the phalanges and the sheaths of the tendons served as adductors and abductors of the respective digits. I could scarcely distinguish which were 'dorsal' and which 'plantar.' That upon the radial side of the 3rd digit in the Seal was very indistinct.

Tibialis anticus (ORYCT.) from the usual position on the outer surface of the tibia and from the tendo patellæ, a broad muscle covering the extensor dig. It formed two tendons above the ankle. Of these, one was inserted into the internal cuneiform bone, and the other into the adjacent part of the 1st metatarsal. (Pl. III.) In PHOCA its disposition was much the same, the slip to the int. cuneif. was however much smaller than that to the metacarpal. (Pl. VI.)

Extensor digitorum (ORYCT.) arose by a strong tendon from the outer side of the fore part of the external condyle

of the femur and slightly from between the tibia and fibula. It divided into four tendons to the four outer toes. They were, however, peculiarly disposed. (Pl. III.) That to the 2nd digit divided on the instep into two, of which the outer passed to the outer side of that digit and the inner sent a slip to the ext. hallucis and then passed on to the inner side of the 2nd digit. The two portions to the 2nd digit then united, forming a tendinous expansion over the first phalanx. Part of this expansion was inserted into the base of the 2nd phalanx; while the narrow remaining superficial part was continued to the base of the terminal phalanx. The 2nd tendon passed to the inner side of the 3rd digit. The 3rd tendon divided; its inner portion passed to the outer side of the 3rd digit, and its outer portion to the inner side of the 4th digit. The 4th tendon passed to the outer side of the 4th digit and to the 5th digit. The tendons were disposed on the phalanges of the several digits in the same manner as on the 2nd.—In PHOCA it was disposed much as in man; and each of its tendons passed over the first phalanx in three bands joined by a web. The middle band was inserted into the 2nd phalanx, and the two lateral bands converged to the middle of the 3rd phalanx.

Extensor longus pollicis, in both, much as in man; except that in ORYCT. it received a slip from the ext. dig., and in the SEAL it passed on to the inner side of the head of the metacarpal over the insertion of the tibialis anticus, and then crossed back again to the outer side of the 1st phalanx, along which it ran to the 2nd phalanx.

Extensor brevis digitorum in both arose as in man. In ORYCT. it had three tendons, which passed to the three middle digits joining the long extensor tendons. In PHOCA it consisted of only two portions, of which one passed to the tibial side of the 2nd digit, and the other to the fibular side of the 4th digit.

Peronei in ORYCT. passed behind the outer malleolus in four tendons. One, from the outer part of the fibula, joined the extensor tendon on the outer side of the 4th digit; a second passed to the process at the outer side of the base of

the 5th metacarpal; and a third passed to the outer side of the first phalanx of the 5th digit. The last two arose from the part of the fibula occupied in man by the peroneus brevis and tertius. The fourth (*peroneus longus*) followed its usual course to the outer side of the base of the 1st metatarsal, but sent a slip to the inner side of the base of the 5th metatarsal; and hence it adducted, or drew towards another, these two toes.

In PHOCA the *Peroneus longus* was attached to the outer condyle of the femur[1] as well as to the fibula. It passed in front of the outer malleolus, then, in a deep groove in the os calcis and the cuboid to the 1st metatarsal. Two other peronei, from the outer and back part of the upper two-thirds of the fibula, descended behind the outer malleolus, crossed beneath the peroneus longus, and passed, one to the base of the 5th metacarpal and the other to the base of the outer side of the first phalanx of the 5th digit.

The effect of all the peronei is to abduct the whole foot; and the two short peronei are the main agents in expanding the paddle.

NECK AND TRUNK.

Sterno-mastoid (ORYCT.) from sternum and inner fourth of clavicle to mastoid; a slip detached from the sternal portion formed the depressor auris. In PHOCA it was a thin muscle arising from the margin of the episternum, and inserted by a small tendon into the mastoid process[2].

Sterno-hyoid (ORYCT.) as in man. In PHOCA, as it descended from its usual position on the hyoid, where some of its fibres were continuous with the genio-hyoid, it spread out, fanlike, and was attached to the sternum, to the inner tubercle of the humerus and to a fascial band (a representative apparently of the costo-coracoid aponeurosis) extending between these two.

This disposition of the muscle shows pretty clearly that the omo-hyoid in Man is a derivative from the sterno-hyoid, that is to say, is

[1] Meckel does not mention this attachment in the Seal, though he observed it in some other carnivora. (*l. c.* 628.)

[2] Meckel did not observe this muscle, and therefore supposed the sterno-mastoid to be absent in the Seal. (*l. c.* III. 424.)

the homologue of the outer portion of this 'sterno-omo-hyoid' of the Seal.

Sterno-thyoid, Mylo-hyoid, Genio-hyoid, Genio-hyo-glossus, Hyo-glossus, Stylo-glossus, Stylo-hyoid (in ORYCT.), and *Masseter* in both much as in man.

Digastricus, in both, from the mastoid process to the angle and lower margin of the jaw. Near its middle it presented, in the Seal, a superficial transverse tendinous division which is probably the representative of the more distinct tendinous division in man[1]. In this animal a portion of it arose from the tympanic bulla close to the styloid process, and seemed to be the representative of the stylo-hyoid.

Pterygoid, in PHOCA, formed one muscle arising from the outer side and edge of the slightly developed pterygoid part of the sphenoid and passing to the inner side of the angular part of the jaw.

Tensor palati, in PHOCA, arose from the sphenoid close to the anterior and outer part of the tympanum, external to the Eustachian tube, passed round the groove in the slightly projecting single pterygoid plate, and expanded into the palate.

Levator palati (PHOCA) from the anterior surface of the bulla, near the preceding, radiated into the palate.

The Eustachian tube just admitted an ordinary probe. Though close to these muscles, it was clear that they could act upon it or influence the condition of its orifice or tube.

Scalenus (ORYCT.) one large muscle descending from the cervical transverse processes down in front of the serratus as low as the 6th rib. In PHOCA it divided as it descended into two portions, of which one was attached to the first rib above the pectoralis minor and the other into the 4th and 5th ribs above the digitations of the serratus magnus.

[1] In the Guinea-pig, where the muscle passes further forward, nearer to the symphysis, the tendinous division is still more marked, involving the greater number of the fibres; yet the muscle has nearly a straight course from its origin to its insertion.

DESCRIPTION OF THE PLATES.

Plate III. ORYCTEROPUS. The integuments have been removed from the left side of the neck and the outer part of the left arm and fore-arm, to display the platysma myoides. A deeper dissection of the right arm and palmar aspect of the fore-arm and paw, and of the right leg and foot are also shown.

Pl. m., platysma myoides. *Sup. l.*, supinator longus.

Depr. aur., depressor auris. *Attr. aur.*, attrahens auris. *Depr. lab. inf.*, depressor labii inferioris. *Bucc.*, buccinator. *Lev. lab. s.*, levator labii superioris. *Lev. n.*, levator nasi.

D., deltoid. *Pect.*, pectoralis major, cut fibres of. *B.*, biceps. *C. br.*, coraco-brachialis. *Tr.*, triceps. *L.*, lumbrici. *Fl. c. u.*, flexor carpi ulnaris. *Sup. l.*, supinator longus reflected. *Pr. t.*, pronator teres. *Fl. c. r.*, flexor carpi radialis. *Fl. d. s.*, flexor digitorum sublimis. *Fl. d. p.*, flexor digitorum profundus.

Tib. a., tibialis anticus. *Ext. d.*, extensor digitorum longus. *Ext. p.*, extensor pollicis. *Per. l.*, peroneus longus. *Per.*, peronei. *Ext. d. br.*, extensor digitorum brevis. *T. p.*, tibialis posticus.

Plate IV. Dissection of the muscles on the anterior aspect of Orycteropus.

(*Left Side.*) *Mas.*, Masseter.

Attr. aur., part of attrahens auris to lower jaw beneath condyle. *Depr. aur.*, depressor auris descending on anterior surface of (*St. m.*) sterno-mastoid. *Ext. jug.*, external jugular vein. *Trap.*, trapezius. *C. h.*, cervico-humeral.

D. D., deltoid. *Subcl.*, subclavius. *Tri.*, triceps. *Sup. l.*, supinator longus. *Sup. b.*, supinator brevis. *Ext. c. u.*, extensor carpi ulnaris. *Ext. min. d.*, extensor minimi digiti. *Ext. ind.*, extensor indicis. *Ext. ann.*, extensor annularis. *Ext. p.*, extensor pollicis. *Ext. d.*, extensor digitorum. *Ext. c. r.*, extensor carpi radialis. *Ext. ind.*, extensor indicis.

S., sartorius. *Add.*, adductors. *V. i.*, vastus internus. *Gr.*, gracilis. *T. p.*, tibialis posticus. *T. a.*, tibialis anticus. *Pl. f.*, plantar fascia. *Fl. d.*, flexor digitorum. *Pl.*, plantaris. *Gastr.*, gastrocnemius. *S. memb.*, semi-membranosus.

(*Right Side.*) *Digast.*, digastricus. *Thyr. h.*, thyro-hyoid. *St. h.*, stylo-hyoid. *St. th.* sterno-thyroid. *St. h.*, sterno-hyoid.

C. br., coraco-brachialis. *B.*, biceps. *D.*, part of deltoid that joins biceps. *P.* pectoralis major. *P. min.*, pectoralis minor.

Fl. d. s., flexor digitorum sublimis: of the division to index finger the superficial part connected with sheath of tendon remains; the strong transverse straps are also seen; in the case of the other fingers the superficial part and the transverse straps have been re-

moved, showing the remainder dividing and giving passage to the tendons of the deep flexor.

Fl. c. r., flexor carpi radialis. *Fl. d. p.*, flexor digitorum profundus. *Pr. t.*, pronator teres. *Fl. c. u.*, flexor carpi ulnaris. *Tr.*, four portions of the triceps. *Subsc.*, sub-scapularis. *T. m.*, teres major. *Scal. ant.*, scalenus anticus. *Subcl.*, sub-clavius. *Pect. min.*, pectoralis minor. *Pect.*, pectoralis major.

Obl. e., obliquus externus.

Gl., glutæus maximus. *S.*, sartorius. *Pect.*, pectineus. *Gr.*, gracilis.

Plate V. Dissection of the muscles on the posterior aspect of Orycteropus.

The *left side* shows the more superficial muscles.

Attr. aur., attrahens auris. *Lev.*, levator auris. *Retr.*, retrahens auris.

Trap., trapezius. Cervico-humeral is drawn aside by a hook.

Tri., triceps.

Lat. d., latissimus dorsi.

Gl., glutæus maximus.

The *right side* shows the deeper muscles.

Temp., temporal muscle. *Spl.*, splenius. *C. h.*, cervico-humeral.

Lev. sc., two portions of levator scapulæ. *Rh. min.*, rhomboideus minor.

Ext. d., extensor digitorum. *Ext. c. r.*, extensor carpi radialis. *Sup. l.*, supinator longus. *D.*, deltoid, the portion of the deltoid inserted into the humerus divided and reflected.

T., the terminal part of (*Tri.*) the scapular division of the triceps reflected to show its insertion into the distal part of the olecranon. *Tr.*, the humeral division of the triceps inserted into the upper part of the olecranon.

Subcl., sub-clavius appearing from beneath the clavicle and attached to the fascia covering the supra-spinatus.

T. min., teres minor. *S. sc.*, supra-scapularis.

Serr., serratus magnus anticus. *Rh.*, Rhomboideus. *Long. d.*, longitudinalis dorsi. *S. l.*, sacro-lumbalis.

Gl. med., glutæus medius. *Gl. m.* (1), origin of glutæus maximus from margin of ilium beneath the anterior superior spine. *Gl. m.* (2), deeper portion of glutæus maximus attached to femur and expanding over knee. The proximal part, or origin, has been removed.

S. memb., semi-membranosus. *S. tend.*, semi-tendinosus. *V. ext.*, vastus externus. *R.*, rectus femoris arising from ilium. *Bi.*, biceps flexor cruris. *Gastr.*, gastrocnemius.

Plate VI. SEAL. Fig. 1. Muscles on hinder aspect, letters as above. Fig. 2. Muscles on anterior aspect. Fig. 3. Muscles of face and ear.

NOTE ON THE ANATOMICAL DEVELOPMENT OF THE RUMINANT STOMACH. By J. GEDGE. Pl. VII. Figs. 1 to 4.

COMPARATIVE Physiologists, in treating of the ruminant stomach, lay great stress on the early development of the fourth or true stomach. The food of the new-born lamb being fluid, no cud-chewing is required; and hence this fact has teleological significance. Upon examining the stomach of a fœtal calf shortly before birth, and observing how greatly the fourth stomach surpassed in size the other three, I became convinced of the truth of this statement, and shortly afterwards on examining a fœtal calf in the fourth month, I expected to confirm my previous observation. Such, however, was not the case; at this period the first stomach was distinctly the largest. Treatises on the subject only led me to infer that the fourth stomach in the fœtal state always exceeded the other three in development. So wishing to explain this discrepancy, I have this year made a point of examining the stomachs of all the fœtal ruminants used in my histological researches; and the result arrived at is, I think, of sufficient interest to merit a note here.

These observations have all been made on fœtal lambs. The stomachs have been carefully filled with fluid without removing the peritoneum so as to separate the cavities; and any incorrectness or inference that might have been drawn from unequal distention of the several parts of the organ has generally been guarded against by examining the stomach of the second fœtus—an advantage gained by using this particular ruminant. Tolerably accurate outlines drawn with mechanical aid are appended in Pl. III. In the place of giving the supposed age the length of the fœtus is in each case indicated.

Fig. 1. Stomach, natural size. Fœtus, 2¼ inches. Here the four cavities are very nearly of equal size. No evident pre-

ponderance of one cavity over another could be made out. In only one instance have I had the opportunity of examining the fœtus at an earlier period; and then the same relative proportion existed.

Fig. 2. Stomach, natural size. Fœtus, $5\frac{1}{2}$ inches. In this case the first stomach (paunch) was seen at once to be nearly twice the size of the other three cavities put together. If we call the 1st, 2nd, 3rd, 4th cavities a, b, c, d respectively, their relative capacity may be briefly indicated thus: $a = 5d$, $b = d$, $c = \frac{2}{3} d$.

It is difficult to understand the purpose of this great development of the paunch at this very early period. It may, however, be accounted for by the fact that during the apparent pause in the development of the fourth cavity the glandular structure of this the true stomach is being laid down. The structure of the walls of the paunch is comparatively ill-developed even at birth. The paunch of a fœtus ten inches in length was still obviously the largest cavity.

Fig. 3. Stomach, one-fourth of natural size. Fœtus, 13 inches. Here the fourth has slightly exceeded the first in size.

Fig. 4. Stomach, one-fourth of natural size. Fœtus, 21 inches. In this instance, we see the proportion of the cavities just before birth, and the preponderance of the fourth cavity is obvious.

ANATOMICAL SCHOOLS, CAMBRIDGE.

ON THE FUNCTIONS OF THE BUCCAL BRANCH OF THE FIFTH NERVE. By JAMES BANKART, M.B., *Demonstrator of Anatomy, Guy's Hospital.*

THE nervous supply to the Buccinator has been for some time the subject of argument, the difficulties in the way of absolute proof in man being great. It could only occasionally happen that an opportunity of making any observations on the functions of the nerves supplying it would offer itself; and the question is so constantly arising both in anatomical and clinical teaching that I have thought that any evidence bearing upon it would be useful, and, for this purpose, have made some experiments in the living dog to ascertain by division of, and application of galvanism to, its two nerves (the fifth and the seventh), which of the two, and whether or not both, supplied the muscle. In these experiments the dogs were kept under the influence of chloroform, and killed by pithing them, before they recovered from its influence.

In man the evidence afforded by disease has been quoted both in favour of the muscle being supplied by the third division of the fifth, and against it. By Dr Todd in favour of that view, and in explanation of the partial paralysis occurring in hemiplegia: Dr Jackson, Dr Saunders, and Dr Wilks taking the opposite view. A paper by Prof. Turner in the *Journal of Anat. and Phys.* I. 83, giving details of a case in which the buccal branch came from the second division of the fifth, seems to be almost conclusive evidence of its being a sensory nerve. The fact, however, of its being still taught by some teachers of anatomy that it is a motor nerve shows that still more evidence may be useful in getting the description of the motor supply to the buccinator removed from the routine of the text books.

In the experiments which follow I was assisted by Mr Joshua Duke.

In the first place, after pithing the dog a dissection was made of the muscles and nerves of the face. The buccal branch

of the fifth was seen lying upon the buccinator and dividing into two branches just as it emerged from under the middle of the anterior edge of the masseter muscle. The fibres of the nerve were traced to the upper and lower lips nearly to the median line. The buccinator was thin, but its fibres were distinct. On first removing the skin and exposing the seventh nerve, the two poles of a galvanic battery applied to a portion of the nerve produced tonic contraction of the muscles towards which the branch ran. By the time that the fifth nerve was dissected out the parts had become rather dry, and no importance was attached therefore to the fact that no contraction followed the application of the galvanic current. No difficulty was experienced in finding the nerve, which emerges from under the masseter at a point midway between the zygoma and the lower edge of the lower jaw. The facial vein runs parallel to the edge of the muscle and close to it, and a large branch from under the ramus of the jaw joins it at a point very nearly over the position of the nerve. The other side of the face was afterwards dissected by Mr Duke. His notes state that the nerve bifurcated far back under the masseter, was deeply placed on the mucous membrane of the mouth, and, apparently, did not give any filaments to end in the buccinator muscle.

In the second experiment chloroform was administered to the dog, and the skin divided for about two inches transversely across the anterior edge of the masseter, nearly to the angle of the mouth. The facial nerve was then exposed, and the vein seen lying close to and parallel with the edge of the muscle. After a little dissection under the edge of the muscle, the upper branch of the buccal branch of the fifth was found and traced up to the junction with the lower branch. The trunk of the nerve was then separated from the surrounding parts, and a piece of glass rod placed underneath it, and the two poles of a galvanic battery applied to a portion of the nerve, but without producing any muscular contraction. On repeating the experiment, some contraction of the fibres of the buccinator followed, but it was then seen that there was a little fluid connecting the nerve on the glass rod with the surface of the muscle. A central branch of the facial was then isolated, and galvanism

applied, when a marked tonic contraction of the buccinator and facial muscles followed. The buccal branch of the fifth was then divided above the bifurcation, and the end placed on a piece of glass and carefully isolated, but no contraction of the muscle could be obtained. This was carefully repeated, with same result. The facial was then divided and placed under the same conditions, marked tonic contraction following each application of the electric stimulus. The same results uniformly followed, and whether the trunk, or the upper or lower branches of the fifth separately, were galvanised, no contraction followed.

The experiment was repeated a third time with the animal under chloroform, but by the time that the fifth nerve was reached the effect had partly gone off, as in consequence of the dog having nearly died the inhalation had been suspended. On taking up the nerve with the forceps the dog was partly roused, and evinced signs of sensibility. The nerve was then divided, and at the moment of division all the muscles were spasmodically contracted, the spasm ceasing immediately. The nerve was divided as high as possible under the jaw, the anterior edge of the masseter being divided to reach it. A piece of thread was then fastened to the end of the nerve, and the nerve held up by it so as to completely isolate it from the surrounding parts, and galvanism then applied. No contraction of muscle followed. A large branch of the facial was then isolated and divided. It was then held up and galvanised in exactly the same manner, and a tonic contraction of all the muscles at the angle of the mouth followed; but the contraction of the buccinator though perceptible was somewhat masked by the action of the other muscles. The separate filaments to the different muscles were then divided one at a time, paralysis of the muscle to which it ran following, until nothing but a fine branch to the buccinator remained and on galvanism being applied, perfect tonic contraction of the whole muscle followed. During this time the animal was kept under the influence of chloroform; it was then killed by pithing it. The contraction of the muscle was still better seen after death than before it, as there was then no chance of its being masked by the respiratory and other involuntary movements, and the

same results continued uniformly to follow the application of the galvanic current. It follows from these experiments that the buccal branch of the fifth nerve is a sensory nerve only and does not supply the buccinator muscle, at least in the dog. It has been argued that after all it only proves the fact as concerns the dog, and that as that animal does not grind its food, that it is of no value as proving the functions of the nerve in man. The relations and distribution of the nerves are so much alike in the dog and in man, that it is at least a fair inference that their functions are so likewise; but, in addition to this, I would submit that the buccinator is quite as necessary for the proper adjustment of the food in the one as in the other, and bears exactly the same relation to the lateral teeth that the lips do to the anterior teeth. In the *Medical Times* of Feb. 22, Dr Beveridge of Aberdeen published a report of a case of disease of the trifacial nerve in which the muscles supplied by the motor branch of the 5th were wasted and paralysed. No mention being made of the buccinator in the report, I wrote to Dr Beveridge, who in reply informed me that although overlooked at the time the report was drawn up for the *Medical Times*, it was noted at the time that no observable change was perceptible in the muscle itself, but that the cheek was considerably emaciated, and the action of the muscle decidedly impaired. I would suggest that there may have been sufficient in the loss of support caused by the wasting of the true muscles of mastication to account for both these latter conditions, and that even the loss of sensation in the mucous membrane of the cheek would to some extent be a cause of want of action of the muscle although there may have been no real loss of power in it, or of nervous stimulus to it.

RESEARCHES ON THE NATURE AND ACTION OF INDIAN AND AFRICAN ARROW-POISON. By HERMANN BEIGEL, M.D. M.R.C.P. Lond., *Physician to the Metropolitan Free Hospital.* Pl. VII. figs. I*a* and II*a*.

THE experiments, the results of which I am about to describe, have been made partly with Indian, partly with African arrow-poison. The composition and action of the one poison is so totally different from that of the other, that it is necessary to treat on them separately.

I. *The Indian Arrow-poison* (*Urari, Woorara, Wourali, Voorari, Curare*) *and its Alkaloid* (*Urarin, Curarin*).

1. *Urari.*

Sir *Walter Raleigh* (in 1595) seems to have been the first who heard of the substance, with which the Aborigines poison their arrows for war and the chase, but neither he nor the authors after him knew anything of the nature and preparation of the poison, which *Condamini, Pau, Bancroft,* and even *Claude-Bernard, Pelouze, Alvaro-Reynoso* and others thought to contain the fangs of snakes, poisonous ants, and other curious substances. Father *Gumilla* and *Hortzinck* gave eccentric descriptions at the commencement of the nineteenth century; and *Waterton,* as well as *Hillhouse,* a colonist of Demerara (who joined himself to the Indians, imbibing all their manners and practising all their habits, and in 1824 published a work in Demerara on the Indian tribes), considers the poisonous ant as the essential substance. But as the book conveyed some rather severe strictures on the mode of treatment, the red nations had received, the governor suppressed it, and only a few copies got into circulation. This writer says: "They (the Accaways) manufacture the Woraly-poison, which they use in shooting feathered game, by means of the woody-fibre of the centre of the leaf of the palm. This is blown through a long tube of

ten feet, which is also a kind of small palm, hollowed for the purpose and lined with a hollow smooth reed; this is called a *Sody*. The Woraly, as generally prepared, has little effect upon the larger animals, but the Macusi-Woraly is sufficiently strong to destroy large animals and even men. After witnessing various methods of preparation, I am inclined to think that the vegetable extract is merely the medium through which the poison is conveyed—the common Woraly owing its poisonous qualities to the infusion of the large ants, called Muneery, and the stronger kind from the fangs of venomous reptiles, particularly the Coony-Coochy, which is the most venomous of all known snakes. The Muneery gives the Indians by its bite a fever of twelve hours, with the most excruciating pain, and a decoction of 200 or 300 of these may well be supposed capable of depriving small animals of life."

This description will suffice to show that the author's attainments of natural philosophy were not very great, he being of opinion that the fangs of snakes are the venomous apparatus.

Humboldt was the first scientific writer who gave an authentic account[1] of the preparation and effects of Urari, of which, according to his own remarks, he first (1804) imported a considerable quantity to Europe[2].

Full light has been thrown on the plant from which the poison is extracted and on the preparation and denomination of the latter by Sir *Robert Schomburgh*[3], who searched for the plant and himself extracted the poison therefrom. "The mystery respecting the arrow-poison of the Indians," says he[4], "although not entirely cleared up, is in a great measure removed. Neither snakes'-teeth nor stinging ants form the active principle, but the juice of a plant," which he has described as *Strychnos toxifera*[5]. This plant is only known to grow in three or four situations in Guinea, and is in its habits a ligneous twiner or bush-rope (which are called in the French colonies *Liane*, and by the Spaniards *Bejuco*). The Indians of the Macusi tribe are the

[1] *Annal. de Chim. et Phys.* 1828.
[2] *Ansichten der Natur.* Stuttgart, 1859, p. 175.
[3] *Annals of Natural History*, Vol. VII. (1841).
[4] Sir Walter Raleigh's *Discovery of the Empire of Guinea*, edited by Sir R. Schomburgh. London, 1848, p. 71.
[5] *Journal of Botany*, Vol. III. p. 240.

best manufacturers of the poison, which is entirely composed of the juice of plants. Previous travellers during the present century in Guinea never saw it prepared, nor did they see the plant growing of which it is made.

The Macusis call the plant *Urari-yè*, the poison itself *Urari*, which the *Carabisi*, who constantly interchange the *r* and *l*, have corrupted into *Urali* and *Ulari*, of which *Wourali* and *Woorara* has been made, the latter name first having been used by *Bancroft*.

Sir *R. Schomburgh* has given an account of the mode of preparing the poison in the *Annals of Natural History*[1], and has prepared it himself by concentrating merely the infusion from the bark of the plant (*Strychnos toxifera*) which has been collected in his presence. It killed a fowl in twenty-seven minutes, although not sufficiently concentrated. Its effect, continues the author, is more or less sudden upon different animals, and the Indians say that monkeys and jaguars are more easily killed with it than any other animal.

The author had been repeatedly assured by the Indians that there is no remedy against the Urari, if it be good. Salt and sugar are both considered antidotes against weak poison, but avail nothing when the Urari is strong.

Amongst the different designations given to the poison, *Urari* and *Curare* seem to be the only well established names. *Urari* is not only commonly used by the Macusi, but also by the *Tarumas*, *Wapisianas*, *Aricumas*, *Wayawais*, *Atorais* and several other tribes of the interior whom Sir R. Schomburgh visited; he considers the compound terms *Uraricapra* and *Uraricuera*, two rivers, as an important argument in favour of *Urari*[2]. But *Keymis*, in his second voyage to Guinea[3], describes a fall of the river *Curwara*, from which *Curare*, generally used on the continent, seems to be derived.

The first experiments as to the action of the arrow-poison have been made by Sir *Benjamin Brodie*[4], who received the Urari from *Bancroft*. Though his experiments have been

[1] Vol. II. p. 407.
[2] *Annals of Natural History*, Vol. VII.
[3] Keymis in Hakluyt's *Voyages*, etc. London, 1600, Vol. III. p. 678.
[4] *Philosophical Transactions*, 1811, p. 207, and 1812, p. 994.

made only somewhat roughly, yet the results are not without interest. "In one case an animal (a young cat), apparently dead from the Woorara, was made to recover, notwithstanding the functions of the brain appeared to be wholly suspended for a very long period of time; in the other (a rabbit), though recovery did not take place, the circulation was maintained for several hours after the brain had ceased to perform office."

It is evidently due to the large doses—two grains to a guinea-pig—that Sir Benjamin came to wrong conclusions concerning the action of the poison. "It is evident," says he[1], "that this poison acts in some way or another on the brain, and that the cessation of the functions of this organ is the immediate cause of death."

When the poison was applied in large quantity, it sometimes began to act in six or seven minutes. Never more than half an hour elapsed from the time of the poison being inserted to that of the animal being affected, except in one instance, where the ligature was applied on the limb.

At about the same time (1813) *Charles Waterton* returned from his travels in South America and brought a quantity of genuine Urari to England, part of which is still in possession of Dr *Sibson*, who in 1839 made a great number of experiments on the poisonous effects of Urari, the results of which have, unfortunately, not been published. But by Dr Sibson's usual kindness I was permitted to make use of his note-book, and must say that he had, at the period mentioned above, arrived at conclusions which many years afterwards have been observed and published by *Bernard*.

[1] The copy of Waterton's *Wanderings in South America*, etc. London, 1852, which was presented to Dr Sibson by the author, contains on the fly-leaf the following dedication: "I offer this little book of wanderings to my dear friend Francis Sibson, Esq., with many thanks for his acts of friendship to myself and to all my family and for his excellent advice. On this day, March 10th, 1864, having the pleasure of his company at Walton Hall, I have presented to him a portion of the real, original Wourali-poison, made and used by the Indians of Maconshia. He may depend upon its being quite genuine, as I took it myself from the gourd in which they had prepared it. They were pointing their arrows at the time, and were poisoning them with it, preparatory for going in quest of game. This was in the year of our Lord 1812, far away in the wilds of Guinea. From that time to this present day it has maintained its deadly virulence, and it is just now in as fine order as it was at the time I procured it. This poison requires to be kept quite dry, nothing more. At all times it is ready for immediate use. Charles Waterton."

I gladly embrace the opportunity of expressing my thanks to Dr *Sibson* for having furnished me with a quantity of his Urari in order to compare it with the poison in the market, to which comparison I shall have to refer hereafter.

Another portion of Urari, imported by Waterton into this country, and still adherent to the original arrows, is in possession of the Rev. *J. G. Wood*, of Belvedere, the author of Routledge's *Natural History of Man*. This gentleman was kind enough not only to present me with some of the Urari but with several other poisons of savage tribes, amongst them a specimen very seldom to be met with, used by the Bushmen and prepared from some peculiar organs of the poison-grub[1]. It is a gratification to me to express my thanks to the reverend gentleman for his kindness in assisting me to extend my researches on the nature of the poisons of savage tribes.

After *Waterton's* return to England, he experimented with Urari-poison at the medical school of Nottingham before a great number of persons, principally professional gentlemen of the town and neighbouring districts. The experiments were superintended by Dr *Sibson*, who had constructed an ingenious apparatus for artificial respiration of the poisoned animals.

One ass was brought to life exclusively by the indefatigable exertions of Dr Sibson, who had continued artificial respiration for seven hours, and ultimately gained the victory over the deadliness of the poison.

The first experiments, however, to show the *physiological* effect of the Urari were published by *Bernard* and *Pelouze*[2] in 1844. These experimentalists established the fact that Urari paralyses the motor nerves, and from this fact the authors concluded the existence of an irritability peculiar to the muscles. The researches have been still more extended by *Virchow*[3],

[1] See Wood's *Natural History of Man*, Part VI. and VII. p. 286, and Bains' *Explorations in South-West Africa*, p. 253.
[2] *Compt. rend.* T. XXXI, and Bernard's *Leçons sur les effets des subst. toxiques et medicament.* Paris, 1857, p. 238.
[3] *Archiv*, Vol. I. p. 249.

Kölliker[1], *Pelikan*[2], *Brown-Séquard*[3], *Eckhard*[4], *Funke*[5], *Kühne*[6], *Pflüger*[7], and others[8].

But all these experiments were made on animals; *Tiercelin* and *Benedict*[9] seem to have been the first who applied Curare as a therapeutical agent for epilepsy, but, for want of Curare, were obliged to give up their task, which was, however, continued by two physicians at Paris, namely, by Drs *Voisin* and *Lionville*, who communicated the results of their researches first to the Société de Médécine and afterwards to the Academy of Paris[10].

The symptoms arising from the effects of Urari, according to these authors, range in two different degrees of intensity, the one to be observed after doses of from 5—9 centigrams, and consisting of defect of sight, heaviness of the eyelids, and sensation of oppression on the frontal region, the other occurring after doses of from 10—13·5 centigrams, and consisting of Diplopia, dilatation of pupils, heaviness in the head, somnolence and faintings. The symptoms of the first order may exist conjointly or follow each other. During about thirty minutes after injection their course is progressive, then they decrease, and the action of the poison lasts for about one hour and a half, after which it ceases without leaving any sequelæ whatever.

The largest dose applied by these authors was 13·5 centigrams. After 10 centigrams the symptoms just described appear more rapidly and in a more intense degree; their duration extends likewise over a longer period. They generally make their appearance after sixteen minutes when 10 centigrams have been taken, and after 12—13 minutes on doses of 11—12 centigrams; duration, from 2—12 hours, and after

1 Virchow's *Archiv*, Vol. x. p. 3.
2 Ibid. Vol. xi. p. 401.
3 *Experimental Researches*, 1853, p. 38.
4 *Beiträge zur Anatomie und Physiologie*. Hft. i. p. 47.
5 *Beiträge zur Kenntniss des Urari. Bericht der Königl. Sächs. Gesellsch. der Wissensch.* 1859, p. 1.
6 *Ueber Pfeilgift. Monatsber. der Berliner Akadem. der Wissensch.* 1860.
7 *Untersuchungen über den Electrotonus*, p. 29.
8 Haber, Ueber die Wirkung des Curare auf das Cerebrospinal systems. *Archiv für Anat. und Physiol.* 1859, p. 58.
9 *Wiener Presse* 1866. No. 32 et 33.
10 *Gaz. des hopit.* 1866. 109 et 111.

their disappearance no sequelæ. But, after large doses, besides the above-mentioned symptoms, sugar may always be detected in the patient's urine, and during the action of the poison no loss of consciousness whatever can be observed; the inclination for micturition is great, and the ophthalmoscope reveals but normal conditions. The pulse becomes, even after smaller doses, stronger, more frequent, and of a dicrotic character, when examined by means of the sphygmograph; temperature somewhat raised, respiration increased in frequency; power of co-ordinate movements entirely or partially lost according to the dose, but electro-muscular contractility intact.

These interesting facts, and particularly the results published by Benedict[1], according to which some cases of epilepsy had been cured "by hypodermic application of Urari, others relieved," I determined to give the method a fair trial at the Metropolitan Free Hospital.

I must confess that my confidence in a remedy over the manufacture of which in the bushes of the Indians we have no control whatever, was not very great, nor was the mode in which Benedict had published his cases of such a nature as to raise confidence; yet he states his results positively, and therefore the duty became incumbent on me, having to treat in the course of a year large numbers of epileptics, to try a new remedy in a disease against which our pharmacopœia generally proves powerless.

The want of confidence I felt from the mode of Dr Benedict's publication was caused by the fact, that the author considered cases of epilepsy "cured" in which for some weeks or months no paroxysms had occurred, and because in other cases he indulged in such expressions as "the result was beneficial."

Every physician who sees large numbers of epileptics knows well that the disappearance of the paroxysms for several months indicates but very little, and justifies him by no means to consider the case "cured," while the phrase "the result was beneficial," means simply nothing.

Before relating the results of my experiments, I shall make a few remarks on the *microscopical appearances* of Urari, refer-

[1] *Wiener medicinische Presse.* 1866. No. 32 et 33.

ring the reader in respect to its chemical composition to the analysis made by Boussignault in 1828[1].

In concentrated solutions of Urari in water or alcohol a sediment settles, which at first sight under the microscope appears an amorphous mass. But if the layer be sufficiently thin for examination, and a drop of sulphuric acid allowed to flow under the covering-glass, the object becomes more transparent and may readily be recognised as consisting of nothing but remnants of plants, different parts of which are easily to be perceived, as seen in fig. II. A.

Whether the broken-down cells are parts of one plant or of more is irrelevant for our purpose, suffice it to say that no traces of animal matter, neither of ants nor of snakes, are to be found, which would undoubtedly be the case if such were used in the preparation of the poison.

The genuine Urari, for which I am indebted to Dr Sibson and Rev. J. G. Wood, is different from that in the market; the remnants of plants being much more numerous in the former than in the latter. The same may be said of the number of the needle-shaped crystals, probably Urarin. Yet whatever the differences in the microscopic appearances of various specimens of Urari may be, all contain a considerable number of the cells A. in fig. II^{A}. so that they seem to be essential. The drawing is taken from a specimen of Waterton's Urari, the larger crystals I. II. having been found in some Urari which I have received a few days ago from Messrs. Brückner and Lampe at Leipzig, who, according to their letter, are supplied by an agent at Rio Negro.

The physiological results of my experiments may best be seen by some of the cases which I have treated by means of hypodermic injection of the Urari-poison.

CASE I.—George Gd., sailor, 25 years of age, unmarried, whose history is in a forensic point of view of great interest. He is the son of healthy parents, has two sisters and six brothers, one of whom, 29 æt., has been subject to fits from childhood, at last became imbecile, and is now an inmate of Colney Hatch.

Nine or ten months ago, when patient was at Malta on

[1] *Annal. de Chimie et de Physic.* Vol. xxxix. (1828), p. 24—37.

board of a man-of-war, he passed some pieces of tape-worm, for which medicine was given and the whole worm passed, whether the head also, patient is not aware of; a few months afterwards a fully developed epileptic fit set on, which did not recur, but very frequently "petit mal" makes its appearance, sometimes three or four times a week. It consists in the patient's rising, when at any work or conversing with friends, asking two or three nonsensical questions, the last of which is generally, "What is the time?" During these questions, patient walks a few times through the room, and then to the chimney, where he passes his urine. Then he returns to his former place and continues either his work or conversation, without any knowledge of what has happened, the whole scene lasting only a very few minutes. Patient has therefore been discharged from service, and on the 23rd of January, 1867, came under my treatment. He is an extremely strongly built man, intellectual, and with the exception of these attacks, he feels very well, all his functions being in perfect order. After having tried Bromide of Potassium and several other remedies, I injected Urari, gr. $\frac{1}{4}$, pulse before injection 74 in a minute,

10	minutes	after	injection	73
20	...	...	...	70
30	...	...	...	79
40	...	...	...	74
50	...	...	...	74
60	...	...	...	74

No other symptoms of the action of the injection. On the 29th of April an injection of Urari 1 gr. was made, and again, besides vacillations of the pulse and an apathetic expression of the countenance, no symptoms were observed. On the 2nd of May $1\frac{1}{2}$ gr. of Urari was injected. Pulse immediately before injection 74.

After	10	minutes	70
...	20	...	77
...	30	...	72
...	40	...	76
...	60	...	72
...	80	...	69
...	100	...	73

About ten minutes after injection the countenance assumed an extremely stupid expression; the eyelids fell down, covering half of the bulbus, vision very much impaired; limbs could be moved by the patient, when in a sitting position, but he could not get up from the chair without supporting himself on his arms, and even then only after several attempts had failed; the gait was staggering as if patient were intoxicated, therefore he got hold of anything near him in order to support himself. With his eyes open he could stand heel to heel, but not with eyes shut. Respiration perfectly unimpaired; action of heart normal; sensibility of skin so intact, that patient was able to distinguish the two points of a pair of compasses within the physiological limits. An inclination to micturition which Voisin and Lionville observed in their patients was not observable. These symptoms lasted for about two hours.

On the 4th of May, repetition of injection of 1¼ gr. Urari; pulse 75.

After	10	minutes	77
...	20	...	76
...	30	...	77
...	40	...	74
...	50	...	77
...	60	...	80

The phenomena were the same as on the 2nd of May, but weaker, although the dose and preparation were the same.

On the 8th of May injection of 1¾ gr. of Urari; pulse 79.

After	10	minutes	84
...	20	...	82
...	30	...	82
...	40	...	82
...	50	...	82
...	60	...	79
...	80	...	79
...	100	...	76

The characteristic expression of countenance this time perceptible a few minutes after injection; the same in respect

to the incapability of executing co-ordinate movements. Pupils much dilated, and rather inert on irritation by light. Vision much impaired; consciousness and sensibility perfectly intact; slight muscular tremor; respiration normal; action of heart rather weak, otherwise regular. Duration of these phenomena about two hours.

On the 11th of May injection of 1¼ gr. of Urari; pulse 76.

After	10	minutes	82
...	20	...	81
...	40	...	81
...	50	...	82
...	60	...	78
...	70	...	78

Phenomena similar to the former, but less strong.

15th of May, injection of Urari, 1¾ gr.; pulse 92.

After	10	minutes	84
...	20	...	84
...	30	...	85
...	40	...	86
...	50	...	87
...	60	...	86

Phenomena as above.

18th of May, injection of Urari, 2gr. Phenomena as before, but still more intense.

Several portions of the skin, where injections had been made, were swollen and painful, and therefore it became necessary to leave the next injection until the 28th of May, when two grains were again injected; the symptoms were very intense, and the condition of the optic nerve, examined by the ophthalmoscope before and after injection was also very peculiar.

Before injection it was seen to have a normal circular shape, but when sight was impaired, besides the vessels of the choroid being more than normally filled with blood, the optic nerve assumed this elliptic shape ●, which again became circular as soon as the power of vision was restored.

This alteration of the optic nerve has been observed in the

same patient several times, and it was of peculiar interest to notice the same alteration during an attack of "petit mal" which occurred when he one day was in my consulting room.

On the 1st of June there was a repetition of injection of 2 grains of Urari, with the same result as before.

We shall have to refer to this patient again when speaking of the action of the Alkaloid of Urari.

CASE II. Lewis Is., a butcher, 23 years old, for many years suffering from epileptic fits, which seem to be hereditary in his family. The attacks are severe, the history of this case does not bear otherwise on the question under discussion. It may therefore suffice to remark, that the patient is of a slim stature and rather weak, colour of countenance pale, mucous membranes the same, Acne all over his face, and the body covered with Psoriasis guttata, which according to patient's statement, is not of a syphilitic nature.

On the 17th of April, 1867, an injection was made of Urari, ½ gr.; pulse before injection 84.

After	5	minutes	87
...	10	...	91
...	15	...	97
...	20	...	91
...	30	...	90
...	40	...	87
...	50	...	90
...	60	..	80

No symptoms whatever of the action of the poison.

May 1. Injection of one grain of Urari, which produced no effect.

CASE III. Henry P., 17 years of age, a robust lad, about a year ago fell from a horse, and since that time suffers from epilepsy. He came under my treatment on March 6, 1867, and on the 1st of May an injection was made of 1 grain of Urari, after which neither subjective nor objective symptoms could be observed. On the 4th, 8th, 11th, 15th and 18th, the same dose was repeated with the same effect. Therefore on the 22nd 1½ gr. were injected; pulse before injection 95.

After	10	minutes	99
...	20	...	105
...	30	...	103
...	40	...	101
...	50	...	106
...	60	...	101
...	90	...	102
...	100	...	99

Fifteen minutes after injection sight became dim, and soon Diplopia set in, the one image being above the other; face turgescent, speech heavy, stupid expression of countenance, upper eyelids dropping down, therefore eyes half-closed; gait uncertain; arms, according to patient's description, felt like heavy weights, and in consequence impossibility to put his hands to his head. Sensibility and intellectual faculties perfectly intact.

February 5, 1868. At half-past twelve one grain and a quarter of Urari were given internally. Patient had eaten nothing since nine o'clock in the morning, when he made his breakfast, consisting of three cups of tea and a few pieces of toast, and declared himself to be rather hungry; ten minutes after taking the Urari his sight was extremely impaired, and Diplopia existed in a marked degree. Patient saw the features of persons present double, and at the same time was well aware of the delusion; he experienced intense pain in the stomach, but it lasted only a few minutes. Examination by means of the ophthalmoscope revealed only normal conditions. The action of the muscles was in no way impaired, probably from the small dose taken; patient could therefore walk firmly, and in spite of impaired vision the upper eyelids did not drop down; the symptoms disappeared after about three quarters of an hour.

On March 18th. One grain of Brückner and Lampe's Urari was injected without producing any effect.

March 21st. gr. 1½. No effect.

March 25th, gr. 2. The same result.

March 28th, gr. 2½ were injected. The symptoms which followed consisted in redness of the face, slight dimness of eyes, and slight uncertainty of gait; which symptoms prove the Urari

used since the 21st of March being weaker than that of Paris, but nevertheless even of Brückner and Lampe's Urari $\frac{1}{8000}$ of a grain was sufficient to kill a large frog.

On the 7th of April patient of Case I. took 3¼ grains internally without exhibiting any symptoms. The thermometer during one hour and a half in patient's axilla remained standard at 38·7 (Cels.), pulse 15 in a quarter and respiration 4. Two hours before injection patient partook of a luncheon, consisting of bread, cheese and some ale.

CASE IV. Julius Is., 16 years of age, 18 months ago was attacked by epileptic fits without any accountable cause. Since that time the paroxysms recurred with terrible frequency. Patient is a well-made lad, but the expression of his countenance indicates great suffering. On the 12th of January, 1867, he came under my care, and on the 1st of May an injection was made of Urari, 1 gr., which was followed by no symptoms.

May 4. Injection of 1¼ gr.; pulse 91.

After	10	minutes	102
...	20	...	96
...	30	...	98
...	40	...	99
...	50	...	95
...	60	...	94
...	80	...	95
...	100	...	91
...	110	...	86

Ten minutes after injection the upper eyelids dropped down, but patient was capable of raising them voluntarily if told to do so. Both palms of his hands were covered with sweat; gait somewhat uncertain, backs of both eyes paler than normal. Besides these symptoms patient complained of dryness in the mouth. Duration of the symptoms about three quarters of an hour.

May 8. Injection of one grain and a half of Urari. The action of the poison this time became already evident a few minutes after injection, and was so intense that patient was

incapable of sitting in a chair, and therefore was obliged to lie down on the floor. Sensibility and mental faculties perfectly intact, but there existed rather severe *tinnitus aurium.* Pupils much dilated, without loss of reaction on light. Action of heart feeble, but normal, respiration perfectly normal; pulse before injection 96.

After	10	minutes	93
...	20	...	92
...	30	...	91
...	40	...	90
...	50	...	89
...	60	...	85

One hour after injection, all symptoms, with the exception of the *Tinnitus,* were still undiminished, and after two hours nearly all symptoms had disappeared, and patient was capable of going home steadily.

May 11. Repetition of the same dose of Urari, with the same result.

Case V. This patient was the first to whom I applied hypodermic injections of Urari, and this accounts for the long time I tried very small doses of the poison without seeing any results, till the experiments of Voisin and Lionville came to my knowledge, which induced me to apply larger doses.

Patient was 18 years of age and strongly built; he was attacked eight years ago, and on the 11th of October, 1865, came under my care.

On the 21st of August, 1866, I injected one-eighth of a grain of Urari, which of course produced no effect whatever; the doses were raised gradually with great precaution and amounted on the 3rd of October to one grain, with negative results. On the 6th of October one grain and a half was injected, which for the first time in my experience revealed the effects of the poison, consisting in this case in loss of control over co-ordinate movements and in impaired sight; after about two hours patient went home, on arriving he fell asleep and slept for many hours.

October 22. Injection of $\frac{1}{2}$ gr. No result.

December 29. $\frac{1}{8}$ gr. No result.

January 16, 1867. $\frac{5}{8}$ gr. Slight dulness of sight, but no other symptoms.

February 6. $\frac{7}{8}$ gr. Dulness of sight of the left eye, no other symptoms.

February 13. $\frac{18}{24}$ gr. Slight dulness of right eye, no other symptoms.

March 16. $\frac{3}{4}$ gr. Beside variations in the frequency of pulse, no other phenomena.

March 20. $\frac{7}{8}$ gr. Pulse before injection 72.

After	5	minutes	72
...	10	...	76
...	15	...	75
...	20	...	73
...	25	...	74
...	30	...	79
...	40	...	76
...	50	...	72
...	60	...	72

Five minutes after injection slight muscular tremor, after fifteen minutes sight of right eye impeded; both symptoms lasting only for a few minutes; no other phenomena.

In order to be enabled hereafter to consider the action both of Urari and its alkaloid at one time, I shall now give the results of

2. *Urarin* (*Curarin*).

As soon as experiments had been made in Europe with the arrow-poison of the Indians, several chemists, *Boussignault*, *Rolin*, and *Trapp*, tried to extract the alkaloid, in order to place the experiments on a more trustworthy basis from reasons already explained; for it is only the alkaloid on the doses of which dependence can be placed, the Urari being a composition, differing not only in different tribes, but even if prepared by the same individual differing according to the care the latter takes in brewing the poison.

The problem of producing Urarin in a pure, crystallized state has satisfactorily been solved by Dr Preyer, of Bonn. The mode

of preparation, as well as the results of some experiments, have been communicated by him to the Medical Society of the Lower Rhine[1], on the 21st of July, 1865. 0·0003 gram. were sufficient to paralyze a frog, and 0·001 gram. produced the same effect on a guinea-pig, weighing 2100 grams., the effect taking place rapidly and lasting about half-an-hour. Dr Preyer experimented with a considerable number of frogs, rabbits, guinea-pigs, dogs, rats, birds, and other animals, and in all the irritability of the muscles remained intact, contracting on direct irritation of the nerves.

Concerning the dose in which Urarin is to be administered, Dr Preyer, according to his paper as well as to a letter written to me, is of opinion that the Alkaloid acts about twenty times as intensely as the Urari from which it has been produced. In a well-grown rabbit $1\frac{1}{2}$ milligr. proves fatal, guinea-pigs died after injection of 1 milligr., and frogs could not survive $\frac{8}{10}$ milligr. Bernard's experiments[2], which Dr Preyer has witnessed, have shown that the mode of injection is of vital importance for the animal. Doses of the alkaloid, which imply no danger when injected hypodermically, proved immediately fatal when injected into the portal vein; and injections into the muscles kill much sooner, if the dose is sufficiently large, than if injected into the connective tissue immediately beneath the skin. Great care must be taken to break no vessel; in fact, it is necessary that after injection no drop of blood should escape. The absorption of the poison under such circumstances takes place but slowly, but the danger at the same time is reduced to a minimum. Bernard placed a piece of sponge, filled with a fatal dose of the poison, under the skin of a rabbit, and though, after twenty-four hours, no Urari could be discovered in the sponge, yet the rabbit exhibited no poisonous symptoms from the slowness with which absorption had taken place.

Of the effect of Urarin in men, Dr Preyer knew only that seven milligrs., equal to one-eighth of a grain, produced no marked symptoms.

[1] *Berliner Klinische Wochenschrift.* 1865. No. 40, and *Comptes Rendus*, 1865, June 27.

[2] *Comptes Rendus*, 1865, June 27.

In October, 1867, I had sent from Mr Kluetech, of Bonn, who prepares the alkaloid according to Dr Preyer's directions, two tubes, each containing 30 milligr. of Urarin. I dissolved the contents of both tubes in five drams of distilled water, so that five minims of the solution contained 1 milligr. of Urarin. On the 26th of October I injected the patient of Case I., 5 milligr. of the solution, without perceiving the slightest effect after two hours. I, therefore, on the 2nd of November exceeded the maximal dose of Dr Preyer by 1 milligr. without producing the slightest effect.

November 9th. Injection of 10 milligrs.; pulse before injection 17 in a quarter of a minute.

After	5 minutes	17
...	15 ...	13
...	30 ...	17
...	45 ...	17
...	60 ...	18

Except slight dilatation of pupils, no effect whatever; urine contains no sugar, background of eyes unaltered, muscular action normal.

November 16th. Injection of 12 milligrs. A few seconds after injection patient perceived a slight heaviness in his head, which only lasted a few seconds. Pulse before injection 19 in a quarter of a minute.

After	15 minutes	13
...	30 ...	17
...	45 ...	18
...	60 ...	18

No other symptoms.

November 20th. Patient tells me to-day that, when he reached his house after last injection, he became sleepy, and slept for several hours.

Injection of 13 milligrs. Immediately after which the pulse was throbbing 19 times in a quarter of a minute.

After	15 minutes	18
...	30 ...	18
...	45 ...	18
...	60 ...	18

No Urari-symptoms whatever.

Having nearly arrived at the double quantity of what Dr Preyer had injected, without seeing any result, I thought that patient's system perhaps enjoyed a certain immunity in consequence of the number of times the injections were applied to him, I therefore injected on Nov. 30th Urari $2\frac{1}{4}$ grs. The symptoms set in a few minutes after injection, and were very intense. Pulse before injection 19 in a quarter of a minute, immediately after injection 19.

After	15	minutes	19
...	30	...	18
...	45	...	17
...	60	...	18
...	75	...	19

About ten minutes after injection the upper eyelids dropped, and the eyes were closed; it was only with great exertion that patient could open them, and keep them open for a few seconds. Speech very heavy, but patient answered questions quite sensibly. The phenomena concerning the optic nerve were again observed, but this time the longest diameter of the elliptic figure was in an opposite direction, viz. thus ●.

When requested to count my fingers, held about 5 feet before the patient's eyes, he declared that he saw nothing, not knowing that his eyes were closed. When his attention was drawn to this fact he opened his eyes and saw all objects doubly, being fully aware of the delusion. Motility was impaired only in respect to the eyelids, organs of speech, and the lower extremities, while the upper extremities were so far from being affected that patient with his own hands held his upper eyelids, while I was examining his eyes with the ophthalmoscope. Respiration was performed freely and energetically, while the action of the heart was weaker than normal, the accent of the second sound being somewhat louder and stronger than is normally the case. Temperature of the skin not raised, no sugar in the urine, no abnormal secretion of the lachrymal or other glands or kidneys. Diplopia lasted for about one hour and a half, and, after the lapse of two hours and a half, patient was enabled firmly to walk home. Sensi-

bility and consciousness were not impaired a moment. No sickness or headache were perceived during the whole time.

Case VI. William M. R., a strong lad of 12 years, suffering for several months from St Vitus' Dance, the right side particularly, both right extremities constantly moving, even when patient is asleep. On December 13th, 1867, 5 milligrs. of Urarin were injected. Pulse before injection 16 in a quarter of a minute.

After 15	minutes	23
... 30	...	22
... 45	...	20
... 60	...	20

A few minutes after injection the boy became pale and faint, pupil dilated, in the course of about a quarter of an hour twice vomiting, after which patient resumed his normal colour, and about an hour after injection no symptom was perceptible except frequency of pulse. The movements of the limbs were not altered during the time. It must be remarked that the little operation of injection seemed to me the principal, if not the only, cause of excitement in the boy.

Urarin being rather an expensive drug I did not feel inclined to continue experimenting with the same.

Thus my experience as to the efficacy of the alkaloid of Urarin is based on negative results.

General Remarks.

The effect of the action of the Urari-poison differs according to the dose which has been injected, this not only being the case in respect to the symptoms observed in men, but also to the phenomena which we are able to demonstrate by physical means in frogs after death. It seems to me that many points, on which some authors are at variance, have their cause in the negligence of not stating the amount of Urari they have been injecting. Claude Bernard's and Kölliker's statement, that the Urari deprives the motor nerves of their capability to cause contraction of those muscles into which they are inserted, is not in compliance with the many experiments I have made.

According to these authors, the sciatic, or any other nerve, may be insulated, pinched and exposed to a strong electric current, without causing one single fibre to contract. This is true when large doses have been administered, but after small doses, 500th or less of a grain to a large frog, diminishes the action of the motor nerves, but by no means destroys it. The sciatic nerves of several frogs, the largest weighing two ounces and a half, and being poisoned by an 800th of a grain of Urari, answered each irritation of an electric current by contractions of the extremity. The same result was obtained by exposure of the lumbar nerves to the current, and the convulsions, in this instance, of the lower part of the back were still more violent when one Electrode was applied to the lumbar nerves of one side and the other Electrode to those of the other side. The convulsions, however, do not last long, and a few minutes must elapse before the experiment can be successfully repeated.

The irritability on direct application of the current to the skin or muscles is undiminished during life and remains intact for many hours after death. This phenomenon gave rise to the opinion of some authors, that the Urari-poison merely affects the trunks of motor nerves, but does not penetrate to the ultimate insertions of these nerves, which therefore are not exposed to the poisonous influence, so that the contraction of the muscular tissue on electricity would merely be the result of the irritation of the intact ends of the nerves contained in the muscles[1]. But Kölliker has shown, by indisputable results of experiments, that the action of the Urari-poison first begins just in these ends of the nerves in the muscles, and he infers from his experiments that the poison, after having destroyed the action of the intramuscular ends, passes on by degrees to the trunks of the nerves, without demonstrably affecting the nervous centres or interfering with the fibres of the sensitive nerves. On these facts Kölliker and Bernard maintained their views of a special irritability peculiar to the muscle; and Funke's[2] objection, that the poison may affect the whole nerve

[1] Eckhard, *Beiträge*, p. 47.
[2] *Lehrbuch der Physiologie*, 1863. Vol. I. p. 961.

with the exception of the very last ends within the Sarcolema, must be supported by graver evidence than a mere presumption, in order to grapple with facts and conclusions based on such. From the results of a large number of experiments, I therefore am in favour of an irritability peculiar to the fibres of the muscles.

The action of the poison is in the first place, as shown by Sir *Benjamin Brodie*, propagated, not by the nerves, but by the blood-vessels. *Claude Bernard* and *Pelouze*[1] were of opinion that no action takes place if Urari be taken internally; but *Pelikan* has shown the fallacy of these gentlemen's conclusion, the doses having been too small and the stomachs of the rabbits used for the experiments too much filled. My own experiments in man have shown the influence of the state of the stomach on the action of the poison. In the one patient (Case III.) who, when taking the Urari, was "rather hungry," the phenomena appeared very rapidly, the doses not being higher than 1¼ gr. while in another patient to whom I administered two grains on the 14th March, no symptoms whatever were perceptible; this patient having had a good breakfast in the morning and a hearty luncheon about one hour before taking the drug.

Claude Bernard, a few years ago, altered his opinion concerning the capability of Urari for being absorbed by mucous membranes. He concedes that the non-absorption through the mucous membrane of the alimentary tract is not absolute. Dogs when in the act of digestion, according to the author, may take considerable quantities of the poison with impunity, which would prove fatal to them when hungry. Absorption takes place likewise through the mucous membranes of the respiratory organs, but not of the bladder, conjunctiva, and the external surface of the skin of the frog.

The symptoms arising from Urari appear in a certain rotation and are so very characteristic that the diagnosis of poisoning by that drug could, I think, be made without difficulty. The first of these phenomena, provided the quantity either injected or taken internally has been sufficiently large to produce an

[1] *Leçons*, p. 282, and *Comptes Rendus*, Vol. xxxi. p. 533.

effect, is the *relaxation of the muscular system*, first noticeable in the altered expression of countenance, this becoming apathetic, stupid, to which dropping of the upper eyelid soon accedes, partially or totally covering the bulb. The individuals under the poisonous influence sometimes not being aware of this occurrence, are under the wrong impression of being unable to see, whilst their eyes are only closed. If told of the error they open their eyes, but are not able to do this as they would under normal circumstances, part of the eye-ball always remaining covered by the lid. When small quantities have been administered, the muscular system does not partake any farther in the affection, but in case of larger doses the control over voluntary movement may be lost entirely, the involuntary continuing, weaker perhaps, but regularly. My experiments have shown that certain parts or groups of the system of voluntary muscles are more affected than others, the upper extremities, for instance, still being capable of performing firmly their movements, while the lower are staggering and uncertain. Death only occurs by Urari if such a dose has been taken as to paralyse the heart or the muscles of respiration, otherwise the heart continues to perform its duty in a regular manner, and even in case of inactivity of the respiratory muscles the animal will be restored to life and health if artificial respiration is performed.

"I have observed," says Dr *Sibson*[1], in his very excellent paper *On the changes in the situation of the internal organs*, etc., "the motions of the heart in the ass in more than one instance. I injected into the jugular vein from two to three grains of the Wourali-poison that was supplied to me by Mr Waterton; I kept up artificial respiration, removed the ribs and exposed the heart. In one ass the heart continued to beat for four hours with full energy; at the end of that time the animal showed signs of returning sensation; I cut out the heart while beating with full vigour. The struggles of the animal did not cause any back-flow of blood into the tied jugular vein

[1] *Transactions of the Provincial Medical and Surgical Association*, Vol. XII. 1854, p. 512. See also Dr Sibson's Paper on the causes which excite and influence respiration. *Ibid.* XVII. p. 309.

through which the poison was injected; the vein swelled behind the ligature. To ascertain the gliding movements of the heart, I fixed pins first into one part, then into another, of the moving walls." Dr Sibson's note-book is full of similar and still more interesting instances; yet the most remarkable are those he superintended when Mr Waterton was experimenting at Nottingham. To one of these cases I have alluded in the beginning of this paper, but, bearing so importantly on the question under consideration, I think it necessary to give two *in extenso,* they being published at full length in the Nottingham newspaper of 1839.

A female ass, 8 years old, of rather poor condition, but previous to operating exhibiting a regular action of the heart—pulse 62—was poisoned at 9 hours 6 minutes in the morning, by an arrow-head being put into an incision made in the neck; at 9h. 12m. pulse 60, and continued uninterruptedly the same for five or six minutes longer, when it began to increase. At 9h. 20m. pulse irregular and risen to 72, the respirations at 14 in a minute, pupils becoming dilated. At 9h. 32m. pulse still 72, the animal manifesting symptoms of uneasiness. At 9h. 36m. pulse 84, and the creature repeatedly lifted its fore legs, which trembled, and the next minute fell down, being exactly 31 minutes from the time of introducing the poison: there was a slight struggling, but the muscular power soon ceased, the pulsation was imperceptible, except a faint fluttering at the heart, and animation appeared to be extinct. The animal was then raised upon a table, an opening was immediately made in the trachea, and at 9h. 41m. artificial respiration commenced by means of Dr *Sibson's* apparatus, consisting of a double pair of bellows, keeping up a constant current of air.

At 9h. 44m. the pulsation became once more distinct, as high as 72, and continued varying for seven hours from 56 to sometimes 100, but most frequently at between 70 and 80. At 7h. 38m. natural respiration was free, and artificial discontinued.

Another experiment was made next morning at eight o'clock on a male ass, about five years of age; it appeared

very vigorous, but with ventral hernia on the right side. It stood perfectly quiet, and the action of the heart was at 36. Mr Attenburrow, surgeon, cut into the trachea at 8 h. 4 m., then an incision was made on the fore part of the right shoulder, into which, at 8 h. 6 m. Mr Waterton inserted an arrow-head with the Woorali on it; the quantity being not quite one-fourth of that used upon the ass yesterday. At 8 h. 16 m. pulsation was 66, and about four minutes afterwards the pupil of the eye became gradually dilated, though the animal stood perfectly patient, manifesting no symptoms of uneasiness. At 8 h. 30 m. pulse 62; at 8 h. 38 m. spasmodic twitchings were evident on the region of the abdomen; the animal still eating, and apparently not much distressed. The next minute the legs trembled, and at 8 h. 40 m. the creature fell on its belly, but tried to rise again. At 8 h. 43 m. the tube was introduced into the trachea; at 8 h. 44 m. action of the heart regular, but respiration convulsive and difficult, with repeated gasping. It struggled occasionally, and at 8 h. 49 m. the pulse was 54, with spasm and difficult respiration, but the pupils of the eyes not so much dilated. At 8 h. 54 m. the arrow-head was withdrawn and no poison remained on it, the pulse continued the same and the respirations were 44, the vision pretty perfect. At 9 h. 7 m. respiration ceased, the vision entirely gone, the action of the heart energetic, extremities warm, throbbing of the carotid artery strong, artificial respiration commenced at an average of 18 a minute, and at 10 h. 25 m. the nostrils gave indications of restored respiration, artificial respiration kept up at 16 per minute, no pulsation perceptible, except in the action of the heart. At 10 h. 27 m. natural respiration recommenced, at 10 h. 36 m. symptoms of returning vision, at 10 h. 40 m. respiration much hurried and irregular, at 10 h. 41 m. artificial respiration discontinued, at 10 h. 44 m. natural respiration 38."

In my own cases both respiration and action of the heart went on regularly even under most marked symptoms. It is true the pulse underwent some alterations, but they could hardly be considered to be governed by certain laws, the number of pulsations immediately after injection being sometimes increased, sometimes decreased, but in almost all cases even-

tually returning to the standard before injection. It must likewise be borne in mind, that the injection of about two grains of Urari cannot be effected without causing some pain which fully accounts for the variations of the pulse.

Some experimentalists have shown the vasa-motor nerves to be paralyzed by Urari, and in consequence the peripheric vessels becoming dilated and giving rise to lower temperature[1]. My experiments have led me to deny the decrease of temperature which either vacillates in a very small degree—according to my opinion, the result of external influences—or remains standard. In a case in which two grains of Urari were effectually injected I measured the temperature, the result is shown in the following table:

Immediately after injection

Minutes.	Pulse.	Respiration.	Temperature.
	47	17	36·8 Cels.
5	65	...	36·8 ...
10	66	...	36·8 ...
15	65	17	36·8 ...
20	65	...	36·8 ...
25	65	...	36·8 ...
30	64	17	36·8 ...
35	66	...	36·8 ...
40	64	...	36·8 ...
45	65	17	36·8 ...
50	68	...	36·8 ...
55	68	...	36·7 ...
60	66	18	36·7 ...
65	...	...	...
70	...	...	...
75	67	17	36·7 ...
80	...	...	...
90	67	17	36·7 ...

The temperature was taken from the mouth, where the bulb of the thermometer remained, of course, during the whole time

[1] Tschechichin's *Mittheilungen aus dem physiolog. Laboratorium zu Würzburg.*

of measurement. I need not mention that the injection was made, and the reading of the thermometer begun, after the mercury had ceased to rise, and remained standard for about five minutes, which in a sensitive instrument is not the case before the lapse of about 15—20 minutes.

These observations are in accordance with those of *Claude Bernard* who does not admit of raising the temperature under the influence of Urari.

Another constant symptom of the effect of Urari is impaired vision. *Voisin* and *Lionville* consider this phenomenon to be the first, but, as I think, wrongly, for, in all cases under my observation, the muscular system was first affected, although the relaxation of the features was the only perceptible symptom. Pressure in the frontal region, heaviness in the head, and similar phenomena mentioned by others, I have not been able to observe, and a few very recent cases, in which the injection was followed by fainting feelings, induced me rather to connect that phenomenon with the mental impression exercised on the patient by the injection. The impairment of vision generally consists of dimness in the eyes and diplopia, the background of the eye generally being paler than is normally the case; but in other instances we find the vessels much injected and, therefore, a larger number of small vessels visible than is the case in a normal eye. The explanation of these phenomena may be found in the paralytic state of the vasamotor nerves. The phenomenon observed in one individual, viz. the alteration of the shape of the optic nerve, is a remarkable fact, and since no real alteration of the shape of the nerve is possible from its position in the surrounding tissues, no other explanation remains but to consider it as a consequence of an alteration of the refractory conditions of the eye existing during the action of the Urari. This opinion has been advanced by Mr *Bader*, ophthalmic surgeon to Guy's Hospital, and by Dr Liebreich at Paris, to whom I have mentioned the case.

The acoustic nerve has been affected in a similar manner to the affection of the optic nerve in one patient; but this affection having been observed once only amongst a large number of cases, it cannot well be considered, I think, a

symptom characteristic to the action of Urari, at least not when small doses are administered.

Amongst the symptoms described by *Voisin* and *Loinville* we find an abnormal secretory action of the glandular system, rigors, excessive heat and general perspiration. Neither of these phenomena have occurred in my cases, except, in one instance, sweat of the palms of both hands. It is not altogether without interest to remark, that this particular symptom is not unfrequently met with in certain diseases connected with derangements of the nervous system, as Epilepsy, Hysteria, Paralysis, etc.

However severe the symptoms may be, consciousness and sensibility remain intact, provided the dose had not been large enough to paralyze the respiratory muscles, otherwise respiration ceases, consciousness is lost, and the animals become attacked by convulsions.

If the control over the co-ordinate movements is but partially lost, the energy of the individual is capable of decreasing that loss to a great extent, so that a patient who declares himself unable to raise his arms, ultimately is capable of doing it, if he be encouraged to do so, and do not give it up after the first attempt has been made.

A most remarkable fact is the recurrence of all the symptoms on the patient's coming into the open air. With a few exceptions all injections have been made by myself at my consulting room, the patients remaining with me until all phenomena had disappeared, vision, muscular action had returned, in short, until the patient was perfectly able to walk home; I only dismissed him, after having been convinced of his being in such a state. On the next visit some patients informed me, that all symptoms they had experienced after injection returned as soon as they came into the open air, and that the symptoms lasted nearly for the same time as before.

In conclusion, it remains only to say a few words concerning Urarin. If Dr Preyer's statement as to the strength of the alkaloid, being about twenty times that of Urari, be correct, the highest dose injected by me, viz. 13 milligr. (about $\frac{1}{4}$ gr.), would be equal to about five grains of Urari, a dose which, un-

doubtedly, would prove fatal. The possible difference of the Urari used by me and that from which the alkaloid has been extracted does not explain the different strength, for experiments made in different parts of Europe have shown that nearly the same doses have been applied with the same results, so that, in fact, the difference in the strength of Urari generally used for experiments seems to vary but little[1].

The largest number of injections of Urari have been made in the patient of Case I. In him the first symptoms of Urari were observable after at least more than one grain (gr. 1¼—1½) had been injected, whilst 13 milligr. of Urarin produced no effect whatever. The conclusion is therefore warranted that Urarin is not six times stronger than Urari, or—to speak still more reservedly—than the Urari used in my experiments. But it must be borne in mind, that 13 milligr. by no means indicated the beginning of the effect, and that I discontinued the application of the alkaloid merely from the costliness of the preparation.

II. *The African arrow-poison.*

Though numerous experiments have been made with Indian arrow-poison from the time when Urari was first brought over to Europe, I cannot find any record of experiments with the poison used by the Africans for turning a harmless arrow into a terrible, deadly weapon.

I therefore gladly embraced the opportunity of making a few trials, the results of which are contained in the following communication.

The poison was taken by me from arrows, sent by R. B. M. Walker from the Gaboon, west coast of Africa, to the Anthropological Society of London.

The *arrows* came from the Isyâsâ and Isyîro tribes, measure about sixteen inches, and have the thickness of a raven's quill. They are very sharply pointed, and the points are

[1] Brückner and Lampe's Urari requires, however,—as found by experiments made, when this paper was already in the press—a dose of three grains, hypodermically injected in an adult, in order to produce the slightest possible symptoms consisting of a mere dimness of the sight.

for two inches covered with a thick layer of the poison, which is of a brownish colour, firm, without smell, of a bitter taste and, like the Urari, easily soluble in warm water or alcohol, on the solution settling, leaving a sediment. The microscope reveals the latter to consist of brokendown vegetable tissues, as seen in Figure II A.

The cells are very numerous, and consist of the different parts of a plant. If a drop of sulphuric acid be added, needle-shaped crystals are formed, probably the alkaloid of the poison.

To be sure that the cells were not scraped off with the poison from the arrow, which seems to consist of a reed-kind, I put sections of the latter under the microscope, but could not discover any resemblance between them and the vegetable remnants of the poison.

As one glance on the woodcut will suffice to show the difference between the tissues of the plants from which the Indian and African arrow-poison are extracted, so will the first experiment show that the action of both are totally different; and in a certain sense, as will be seen hereafter, acting in opposite directions.

A small piece of the poison being placed under the skin of a middle-sized frog, the animal died in about ten minutes in convulsions.

Another frog, poisoned by Urari, survived a few minutes; but on opening both frogs, the heart was actively beating in the latter, but standing still in the former, and on application of the electric current to both frogs, about half an hour after death, not the slightest reaction was perceptible in the one poisoned by the African poison, whilst the other maintained its irritability on electricity for many hours.

This experiment, though roughly made, warranted the conclusion, *that the African arrow-poison affects, in the first place, the nervous centres, and destroys at the same time the irritability peculiar to the muscles.* This conclusion has been fully borne out by the following experiments:

Two grains of the poison were dissolved in one drachm of distilled water, and the experiments made on five healthy, large frogs, four of which had injected a tenth of a grain each, while

the fifth was made to swallow a somewhat larger quantity. For comparison's sake, a sixth frog was poisoned by an equally large dose, as in the first four frogs, of Urari.

The first fact observable was the more rapid action of the Urari-poison; for the urarirised frog after a very few minutes began to lie flat on the table, the hinder legs extended, while the other frogs at this time were still jumping about without exhibiting any sign of affection. But after about ten or fifteen minutes their movements began to be slower; yet complete paralysis could only be observed after about three quarters of an hour.

It is well known that urarirised frogs are most appropriate objects for observing the circulation of the blood, provided such doses are given as to paralyze, but not to kill the animals. But in the frogs treated with African poison, the circulation could already be seen going on very slowly when the first sign of beginning paralysis consisted only in slow movements.

The state of sensibility was likewise very different. The urarirised frogs, as already mentioned, retain for a very long time the capability of being convulsed by the electric current when applied immediately to the skin or muscles, and to a certain extent even when applied to the nerves. This property exists only a short time after the death of animals poisoned by the African arrow-poison, and after about half an hour neither direct nor indirect application of the strongest current, applied to the skin, muscles or nerves, will cause any contraction of the frog's muscles.

In another series of experiments five large frogs were injected with the following doses of the African poison:

No. I. Two milligrs.

No. II. One milligr.

No. III. One-tenth of a milligr.

No. IV. One-twentieth of a milligr.

No. V. One-fortieth of a milligr. = 0·0640 grains.

Frog No. I. After five minutes paralysis ensued, and although twitching on the skin by means of a forceps still produced reaction of the muscles, yet when the thorax was opened the heart was not beating any more, having ceased to throb after

a systolic movement, the ventricles being pale and empty, the auricles teeming with blood.

Frog No. II. The same phenomena, but beginning somewhat later. When the hinder legs were still energetically moving, on irritants being applied to the skin, the blood-corpuscles under the microscope could be seen moving very slowly in the vessels of the web, indicating that paralysis of the heart and vessels had begun; in the finest capillaries circulation had ceased altogether, and when the thorax was opened, after another minute, the heart was found in the very same condition as described in No. I.

Frog No. IV. died twenty minutes after injection, and

Frog No. III. about three minutes later.

Frog No. V. died after one hour and a few minutes, under the same symptoms as the others.

In all animals the application of the electric current to the nerves remained without any effect, while sensibility in some frogs could be seen on application of the current to the skin or muscles for a few minutes after death, in others for about an hour, the frogs treated with the smallest doses always retaining sensibility for the longest period, which did not, however, extend over an hour.

These experiments have, of course, to be repeated with more care; but from the results already obtained, we may infer that the danger of the African arrow-poison exceeds by far that of Urari, provided a sufficient quantity be introduced into the system of men or animals.

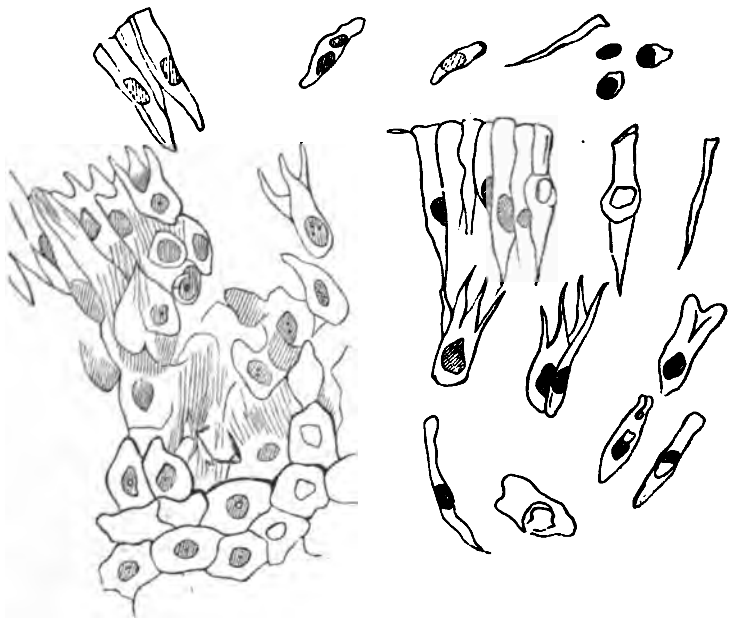
Ceteris paribus, there is a chance of recovering from poisoning by Urari, if respiration is not impaired, or if artificially continued, while all hopes at once vanish if the African poison has taken effect on the centres of the nervous system; and unfortunately the quantity required for this effect seems likewise to be very small.

ON THE EPITHELIUM OF THE CORNEA OF THE OX. By JOHN CLELAND, M.D., *Professor of Anatomy and Physiology, Galway.* (Communicated to the British Association at Dundee, September, 1867).

IT is well known that there are many appearances in stratified epithelia not easily explained by that simplest theory of their growth which is naturally first suggested, and is no doubt in all instances partially true; namely, that cells originating in a deep position pass gradually to the surface as they grow and alter in figure, while those superficial to them are cast or dissolved, and others behind them follow in their steps. Thus the elliptic cells in the deeper strata of the epithelium of the trachea can scarcely be supposed to be developed into the ciliated columns which lie over them; and it cannot be imagined that in the ureter the large and irregularly shaped cells are altered so as to form the smaller and flatter cells found on the surface.

In the cuticle, it is obvious that the horny portion is formed of cells derived from the deeper part and progressively finding their way to the surface where they are cast off; but the elongated form of the cells resting on the dermis, and the size of these as compared with those above them, shows that in this part there is another mode of growth not yet sufficiently investigated. The epithelium of the cornea, whilst it presents the same general arrangement of parts as the cuticle, is a much more delicate structure; and on account of the individual cells being more readily separated, it is much more easily examined: it may be studied without much difficulty with the aid of carmine-staining and bichromate of potash. In the human subject the deepest layer of the corneal epithelium consists of cells not more elongated, in comparison with those superficial to them, than the deepest cells of the cuticle; but in the ox, the sheep, and the horse, and probably other animals, it presents the appearance of a stratum of columnar epithelium, the cells of which are as elongated in form as those of any columnar epithelium in

the body. In the ox the cells are of large size. The elongated cells now mentioned, flat at one extremity, and pointed or caudate at the other, differ from those of columnar epithelium, not only in forming the deepest instead of the most superficial layer, but in having the flat extremity resting on the subjacent parts. The whole thickness of the epithelium, when swollen by the action of the bichromate, can be easily detached from the surface of the cornea, which is left quite clear of any structure from which the epithelium could be derived; for the only nuclei which it exhibits are the long-shaped nuclei in its interior, which are totally different in appearance from the nuclei of the epithelium. When the detached epithelium is examined in vertical sections, the elongated elements forming its deepest layer are seen to lie closely together with their flattened extremities in a line, and each cell exhibiting only one nucleus, which is always at a considerable distance from the corneal ex-



Note of explanation to figure. In this figure the epithelium cells lying next the cornea are at its upper part, whilst the superficial squamous layer is below.

tremity. Thus it is very obvious that the epithelium is not derived from the subjacent cornea, but that the cornea and epithelium are wholly independent structures adhering together.

Immediately superficial to the columnar stratum is a layer of cells of irregular shape, about twice as broad as the columnar, but by no means so elongated. They are rounded and even in outline at the superficial extremity, but are jagged at the other, sending in processes or digitations which may be three or four in number, and which appear to fit in between the tapering points of the columnar cells. The cells resting on this layer are still less elongated and smaller; and it is in this region,-in the middle depth of the epithelium, that it is most difficult to distinguish the component elements as they lie in position. Carrying the examination still onwards toward the surface, large cells are again met with, superimposed on which are others of a flatter form; and at last the squamous layer is reached which covers all.

By subjecting the dyed epithelium to a strong solution of the bichromate of potash its elements may be completely isolated, and then there are seen floating numerous smaller corpuscles than could be well distinguished when the parts are in position. Among these are apparently free nuclei, and others within minute corpuscles of spheroidal or less regular form; also, bluntly spindle-shaped cells containing sometimes a single nucleus, sometimes two, and occasionally a nucleus in process of division. These spindle-shaped cells have their position between the processes of the columnar stratum and among the digitated cells which are next to it.

Here and there in the columnar stratum an appearance of great importance is seen, namely, cells in various stages of decadence. Cell-walls, shrivelled and narrow, without any appearance of a nucleus occur, which might be supposed to have been torn and deprived of the nucleus in manipulation were it not that other stages of old age are observed. Columnar cells retaining their general form are noticed, which have the nucleus replaced by an air cavity with generally the appearance of thickening of the wall round it, as if from desiccation of the cell contents: numerous others may be seen in which, while the cell contents

seem yet unaltered, the nucleus is partially replaced by an air cavity lying close to the remaining portion. Other cells beside the columnar may sometimes be found undergoing the same degeneration; and in the sheep these air cavities are specially numerous in the squamous stratum of the corneal epithelium.

The appearances now described seem to prove conclusively two points; firstly, that the corneal epithelial cells are not developed in regular succession from the deepest part and pushed outwards as they grow; and, secondly, that they are not all cast off at the surface, but that some of them degenerate and are absorbed in a deep position.

The source of origin of the columnar stratum is not to be found on its deep surface; and the digitated cells are certainly not altered and more fully developed columnar cells. But it is alleged by Dr Schneider, as quoted by Dr Sharpey[1], that the elongated cells of the deepest layer of the corneal epithelium, although not themselves passing to the surface, detach from their outer extremities, by repeated division of their nuclei and cell-walls, a series of progeny one after another, from which are derived the other strata. The proof that this is not the mode of growth of the corneal epithelium of the ox is that the columnar cells have never more than one nucleus each, and none of them present any trace of such budding; and also that the superjacent digitated cells are larger than those more superficial. Altogether there can be little or no doubt that the cells of the columnar stratum are derived from corpuscles which grow inwards, and that the spindle-shaped cells above described are, some of them, destined to become developed into columnar cells. We must suppose that the digitated cells are developed in the same manner; and in that case the corneal epithelium may be regarded as having its germinal stratum in its middle depth, from which growth proceeds toward both the cornea and the free surface.

The degenerated cells with air cavities, found in the deepest stratum, point to a circumstance not hitherto observed, nor possibly suspected, namely, that the old elements of a stratified

[1] Quain's *Anatomy*, seventh edition, p. lvi.

epithelium are not always thrown off at the surface; for in this instance they degenerate and disappear in their original position, their parts being doubtless ultimately absorbed, in like manner as a degenerated muscular fibre is absorbed in the uterus after labour, or in a striped muscle.

While, however, the importance of the preceding observations consists principally in demonstrating the possibility of modes of growth more or less similar to that described in the corneal epithelium of the ox occurring in other stratified epithelia, it is not hastily to be presumed that the growth of the general epidermis necessarily proceeds in the same way as that of the corneal epithelium. In particular, it must be recollected that the corneal epithelium is uniquely situated in being spread over a non-vascular texture, and in being continuous at its periphery with a denser epithelium which has blood-vessels beneath it; and it may be therefore fairly questioned how far it derives its nourishment from beneath, and how far from the vessels around it.

A further investigation into the growth of the cuticle is naturally suggested by the facts now brought forward, and I have to regret that as yet I have not had time to pursue that subject with sufficient care. But I may mention that in the deep parts of a delicate piece of cuticle I have been able to see cells with the nucleus partially replaced by a cavity, and others in which it was wholly so.

NOTES ON THE STRUCTURE OF A MONSTROUS KITTEN. By W. C. M'INTOSH, M.D., F.L.S. Pl. VIII. and IX.

THE specimen (fig. 1) from which the following notes were taken was kindly sent me early in 1861 by Dr David Lyell, of Newburgh, and seems to come under Order 5th of Prof. Allen Thomson's classification[1]. The skin was covered with such a coat of hair as usually met with in fully developed kittens at the time of birth. Upon the roundish nondescript head were three external ears, two of which were symmetrical and apparently of normal aspect, and situated a little above a line running backwards from the posterior angle of the mouth; while the third (fig. 11) held an intermediate position on the upper and posterior part of the cranium, and consisted of two coalesced organs, with the tip of each folded over in the form of a flap. In the slight eminence behind the latter was a fissure about one-eighth of an inch in depth, and terminating in a cul-de-sac. In front of the flaps there was also a slight dermal ridge with a superficial furrow. The whole mass, however, moved easily on the subjacent textures, thus presenting a marked distinction from the other two ears, which were of course quite fixed. On the left side of the head there were half-opened eyelids; but on the opposite side only a deep hollow beneath the projecting frontal region (*a*, fig. 2). A fissure on the right side of the nose communicated with a fissure of the palate. The two fore limbs on the right side were in the usual position, while the right fore limb of the left monster had the shoulder pushed three-fourths of an inch forward, the limb being laid over the anterior part of the chest and root of the neck, with the toes looking over the left shoulder. The external separation of the two bodies occurred about an inch and a half behind the anterior extremities. In the angle of junction were two umbilical cords, which, how-

[1] *Monthly Journal of Medicine, &c.* 1844, p. 483.

ever, soon coalesced, and ended in the usual chewed tip. Posteriorly the right monster was rather more bulky than the other, and it was to this side that the head inclined, while the compound ear faced the LEFT.

Head. This was marked by the great development of the right parietal and frontal regions (fig. 7). The right frontal was subdivided into several pieces, and instead of the osseous ring of the orbit being formed of three bones (frontal, malar, and superior maxillary) as in the normal young or adult, no less than eight different pieces were concerned in this case. As the true orbital cavity, however, was extremely small, we may suppose several consisted of osseous elements extruded therefrom; indeed six of the eight may thus be referred to the frontal, viz. *c*, *d*, *f*. *g*, *s* and *s'*, the two latter at least representing the displaced orbital plate. The malar (*o*) and superior maxillary (*i*) held nearly their normal positions, though both were small and contorted. A fibro-muscular layer (*e*) stretched over and completely shut in this cavity, but there was no trace of an eye. The left orbit, again, was somewhat shallow and small, from the pressing outwards of the orbital plate of the frontal, but it contained an eye of the ordinary structure in all respects.

The lower jaw was single and fairly developed, and the cavity of the mouth held a normal tongue, with an epiglottis and rima immediately behind, and in connection with the exterior or upper trachea (*e*, fig. 5). Behind the foregoing another rima opened, with its epiglottis arranged in the reverse way, as if another mouth had entered at the occiput. The epiglottis in the latter case was larger and more lax than the former, and running backwards from its root was a small slightly elevated triangular process covered with papillæ – the representative of a tongue. It terminated in a cul-de-sac. Thus the foregoing sets of organs were situated opposite each other and reversed, the single pharynx and gullet dividing them. Just above the epiglottis of the imperfect apparatus was a cul-de-sac in the mucous membrane of the roof of the chamber, apparently representing a trace of the posterior nares, while from the central eminences caused by the united ampullæ immediately behind hung two fleshy processes.

In the roof of the mouth anteriorly—instead of the flattened arch of the superior maxillary and palate clothed by the rugose mucous surface—there was a highly arched vault covered with smooth mucous membrane, with a projecting ledge of the palate and superior maxillary on each side just beneath the alveolar process of the latter. Towards the anterior part of this ridge there were traces of the rugose mucous surface. The true arch of the palate, therefore, was imperfect, a fact more clearly shown on removal of the soft textures. Anteriorly there were two slender styliform prolongations of the incisive bones in the central line, the very large fissure on each side having no posterior boundary, but being continuous with the arch of the palate. Behind these the arch was made up of two elongated flattened processes, probably representing the vomer, with an intervening mass of cartilage; next, of the much expanded ascending processes of the palatines; and posteriorly of the equally flattened pterygoid plate of the sphenoid. The cavities of the nose and mouth were thus thrown into one throughout the greater part of their extent, for, though there was an imperfect nasal cavity in front at the tip of the snout, it speedily merged into the incisive fissures. The body of the sphenoid (basi-sphenoid) was occupied by a large oval foramen.

It was in the occipital region, however, that the most remarkable abnormality occurred. Behind the bony ring formed by the basi-sphenoid round the aperture just mentioned, a triangular piece of cartilage of considerable size was interpolated, or rather the ordinary spheno-occipital synchondrosis was greatly hypertrophied; and from this, as a centrum, a basi-occipital of a wedge-shaped (and therefore somewhat normal) outline diverged on each side to an occipital foramen. The occipital was formed of four pieces, a large supra-occipital plate to which the triangular lateral piece of the inter-parietal was articulated, two ex-occipital, and the foregoing basilar portion, the whole enclosing a deep pit for the lodgment of the cerebellum and medulla. The cavity was further made up of the temporals. The corner of the superior plate and the condyloid portions of the occipital articulated exteriorly (in regard to the single anterior region of the head) with the cartilaginous mastoid, and a very

much enlarged ampulla, which lay along the basilar piece somewhat after its ordinary arrangement. On the inner side again the cartilaginous mastoids of opposite sides coalesced in the middle line posteriorly, while in front of this mass the corresponding ampullæ were ankylosed. The latter were much smaller and less rounded than the exterior pair, as well as somewhat contorted, but they presented an external meatus posteriorly, though no ring for the attachment of the ear existed. These ampullæ were covered externally by mucous membrane, from which depended the two symmetrical clavated processes referred to previously as being directly over the imperfect tongue. On the inner surface of the skull a prominent bilobed ridge was formed posteriorly by the united elements of the temporals, which thus made a septum between the two occipital fossæ. There was only an indication of the tentorium towards the outer borders of the fossæ. Each occipital region had its foramen and two well formed condyles, with atlas, axis, and succeeding vertebræ. The inter-parietal bone was enormously developed, consisting of a somewhat hexagonal central mass with two triangular wings (indicated in fig. 3), instead of the usual *os triquetrum*. The central piece had a projecting process both anteriorly and posteriorly, the latter filling up the notch between the double occipitals.

The anomalous brain cavity just noted was lined internally by a dura mater, which accommodated itself to the various irregularities, and covered over the gap in the bulging right orbital region. The cerebral substance was not in a good state of preservation, but it was seen that anteriorly the cerebral lobes were divided by a wide and jagged fissure, the largest half being situated to the left. The cerebellum was distinctly double, as were also the pons and medulla, the latter terminating on each side in a well formed spinal cord. A strong falx separated the divisions of the cerebellum. The cerebral nerves in front of the bifurcation seemed to be single, those behind double. The arrangement of the spinal nerves was pretty normal in each monster.

The *muscular system* was well developed throughout, and presented corresponding irregularities with the conformation of

the specimen. The general relations of these are shown in the drawings (figs. 2, 4, and 5, and figs. 8 and 9) and their explanations, and I may only notice that the *pectoralis major* of the right monster (*h*, fig. 2) was peculiar in so far as its humeral portion was of great bulk and breadth, binding the limb forcibly to the thorax, and of course would necessarily have proved an impediment to the free motion of the organ. Each pair as viewed in the drawing were connected with the limbs of different monsters. The *external oblique* (*m*, fig. 4) interdigitated with the former, continued outwards in a slanting direction, and then bending, each proceeded to its respective abdomen. In such views as the foregoing the cervical muscles, e.g. sterno-cleido-mastoid and hyoid, spring from the two monsters yet apparently form symmetrical pairs. The deep-seated muscles, however, of the neck and trunk were in general confined to their respective moieties.

Thorax. The ribs coalesced by cartilage in the middle line so as to form a large compound chest with double organs. The tracheæ were not arranged in a manner corresponding with the two spinal regions, but took their directions rather from the single lower jaw, the one being anterior in such a position as shown in fig. 5, pl. I., and the other posterior; and the lungs followed a similar arrangement. Thus the pair of lungs did not correspond with the pleural cavities of each monster, but belonged to both. The rings of the tracheæ were well formed, and had the intermediate elastic membranous portion posteriorly or otherwise. Each branch of the trachea (*e*) chiefly exposed in fig. 5 became connected with a minute lung which evidently had never been distended with air. The one organ had five and the other two lobes. The irregular thoracic cavity in which they lay likewise contained a small but perfect heart (*i*, fig. 5) enveloped in a pericardium. The aorta of this heart is observed to course to the left of the same figure (right animal), and to give off the usual branches, but the common carotids (*d*) proceeded upwards to supply both sides of the compound cranium. The thymus gland (*h*) was moderately developed.

On removing the foregoing organs a diaphanous membra-

nous septum was found separating this cavity from another which lay under the united ribs on the opposite side (fig. 3), and which corresponded to the dorsal region, if we take the head only into account. The undermost trachea (of fig. 5) gave a bronchus to each lung (*d* and *e*), both of which were considerably larger than in the previous case. The left (*e*) was of an irregular flattened form divided into four very distinct lobes, while the right was simply bisected by its transverse fissure. A curious heart (*c*)—of much smaller dimensions than the first-mentioned—lay in the upper lobe of the right lung, and surrounded by an imperfect pericardium. Careful dissection showed the presence of four cavities, but the right ventricle especially was indistinct, and could scarcely be observed amongst the muscular papillæ. The aorta, ductus arteriosus and other tissues were matted together, the former slanting inwards and forwards to supply the opposite monster (left in fig. 3). The thymus gland (*b*) of this side was larger than in the other cavity.

The thoracic walls were closed inferiorly by an irregular diaphragm, in which the aperture for the single œsophagus was somewhat large. The latter coursed through the chest between the tracheæ.

On slitting open the *abdominal region* on the side corresponding to the view given in figs. 4, 5 and 6, the organs are found in one chamber in front. The œsophagus led into a single stomach which lay in the forward curve of the diaphragm. The stomach had the usual shape, though perhaps the cul-de-sac at the pyloric end was exaggerated. Its mucous surface (which had numerous longitudinal rugæ) was covered with soft masses of nucleated cells—cylindrical, fusiform, and nearly circular—and granules. The intestine was retained in situ by mesenteric bands, and lay chiefly in the cavity of the left animal in the figure (fig. 6). About seven inches from the pyloric end of the stomach a bifurcation of the intestinal tube occurred (fig. 10), one branch coiling to the hollow in the right animal, the other remaining in the left. After a course of about two inches each ileum opened by a proper ileo-cæcal valve into the cæcum (*d*), and the gut then proceeded in the usual manner to terminate in the anus. In the brownish contents of the cæcum were

numerous cellular masses and crystals of the triple phosphate; while the meconium in the rectum consisted of dark red granular matter, epithelial débris, and crystals of cholesterine.

Attached to the abdominal cavity of the left animal above the kidneys was a long, narrow and irregular spleen. The other abdominal viscera were double. The liver in the left animal (*e*, fig. 6) had a somewhat pyriform and elongated shape, with several lobes and fissures; the second liver had a similar shape, with the broad end in front, and an almost pointed posterior extremity. The ducts of both opened into the duodenum. The kidneys occupied a pretty normal position in each monster, and had the usual arteries and veins. A pyriform bladder (*g*, fig. 8) attached to the urachus lay above each pubis.

The generative organs (fig. 8) in both cases were female, and marked externally by the vagina with its clitoris, the latter being much more developed in the left than the right monster. Each was furnished with a small uterus, the Fallopian tubes of which stretched as far forward as the kidneys.

As previously mentioned the umbilical cord was double, consisting of two umbilical veins and four umbilical arteries. The division of the cord took place on entering the abdomen, each set of vessels coursing to its own side. There was a lacerated wound at this part of the abdominal wall, apparently from the efforts during parturition.

Explanation of Plates VIII and IX.

Fig. 1. View of the specimen somewhat reduced in size.

Fig. 2. Superficial muscles from the aspect corresponding to the dorsal region of the cranium. *a*, prominence caused by the hypertrophied right frontal. *b*, fissure of the compound ear. *c*, muscular fibres prolonged from the pectoralis major. *d*, portion of the united trapezius and deltoid. *f*, representatives of the sterno-cleido-mastoid muscles. *g*, spine of the scapula. *h*, pectoralis major. *i*, muscles of the shoulder. *j*, obliquus externus abdominis.

Fig. 3. View of the contents of the 'dorsal' thoracic cavity exposed by severing the commissures of the ribs. *a*, cervical muscles. *b*, thymus gland reflected. *c*, heart. *d*, *e*, lungs. *f*, diaphragm.

Fig. 4. The opposite side from that represented in fig. 2. *a* and *b*, irregularities of the abnormal orbit. *d*, submaxillary glands. *e*, *e*, symmetrical ears. *f*, sterno-cleido-mastoid muscle. *g*, hyoid group. *h*, common carotid artery. *i*, *k*, portion of the united trapezius and deltoid muscle. *l*, pectoralis major. *m*, obliquus ext. abdom.

Fig. 5. A deeper dissection of the same region with the pericardium reflected. *a*, submaxillary gland. *b*, hyoid bone and apparatus. *c*, hyoid muscles. *d*, common carotid artery. *e*, tracheæ. *f*, arch of the aorta. *g*, right auricle. *h*, thymus gland. *i*, right ventricle.

Fig. 6. Common abdomen slit open on the same side as fig. 5, pl. I. *a*, vena cava. *b*, conical diaphragm. *c*, *c*, reflected abdominal walls. *d*, ligament of the liver and umbilical vein. *e*, liver. *f*, spleen. *g*, fold of mesentery. *h*, edge of the second liver. *j*, margin of the right kidney of this monster. *k*, fold of intestine.

Fig. 7. Drawing of the right side of the head after removal of the cutaneous textures. *a*, right parietal. *b*, interparietal and its appendages. *c*, abnormal development apparently of the external angular process of the frontal. *d*, *f*, *g*, *s* and *s′*, separate pieces described in the text. *e*, muscular coating closing in the cavity. *h*, a small sulcus between the frontal and superior maxillary (*i*). *k*, nostril. *m*, muscles of neck. *n*, right external ear. *o*, malar bone.

Fig. 8. Abdominal and pelvic regions of larger monster. *a*, left kidney and its hilus (*b*). *c*, colon terminating in rectum. *d*, upper extremity of Fallopian tube. *e*, left hypogastric artery. *g*, bladder terminating superiorly in the urachus. *h*, left Fallopian tube. *i*, left round ligament. *l*, junction of the Fallopian tubes at the fundus of the uterus. *m*, left lateral ligament of the bladder. *n*, vaginal canal. *o*, symphysis pubis.

Fig. 9. Left dorsal ridge and scapulæ. *a*, subscapularis of right side. *b*, *e*, slips of united trapezius and deltoid. *c*, *d*, levator anguli scapulæ. To the left of the latter are seen the muscular bands corresponding to the rhomboideus major and minor. *f*, *h*, serratus magnus. *g*, spinal muscles *en masse*. *i*, pectoralis minor.

Fig. 10. Intestinal canal reduced in size. *a*, portion of stomach cut open. *b*, duodenum. *c*, point of bifurcation of the small intestine, probably at the termination of the jejunum. *d*, caput cæcum. *e*, colon.

Fig. 11. The compound external ear situated over the region of the coalesced petrous portions of the temporal bone.

REVIEWS AND NOTICES OF BOOKS.

A Monograph on the structure and development of the Shoulder-Girdle and Sternum in the Vertebrata. By W. KITCHEN PARKER, F.R.S. F.L.S., issued by the Ray Society, 1868.

RARELY, very rarely, does a work so thoroughly good and truly scientific as this issue from the press, one which so entirely comes up to our idea of what a monograph ought to be. Facts in vast array, but not superfluous, carefully observed, for the most part worked out by the author with infinite pains and scrupulous accuracy, are detailed in a lucid interesting manner, the description being lightened by the glowing, the almost poetic, touches of the ardent investigator of nature; and all are combined in an orderly manner to tell their own tale of their real nature and their relations to one another. The pleasure and pride with which we welcome such a work is not a little enhanced by the recollection that it comes from one whose time is chiefly spent in the busy distracting turmoil of medical practice, in the provision for the *res domi*, from one who has no ordinary end to gain, who is stimulated by no mercenary or ambitious motive, but whose heart is *en rapport* with nature, whose love it is to commune with her in her deeper chambers, to strike light by sharp contact with her there, and to guide others along the paths which he illumines. We may, indeed, point to Mr Parker not only as a teacher of men of science, but as an example to men of practice, an example not a little needed now-a-days. Thirty large plates, containing each from ten to five and twenty well-executed drawings, by the author's own hand, of his own work, attest to the labour which has been bestowed; and the earnest, thoughtful, happy tone of the work show the spirit in which it has been done. The Royal Society, with judicious liberality, granted a hundred pounds towards defraying the expenses of these plates; and the Ray Society well deserves the thanks of its subscribers for placing such a volume before them.

The shoulder-girdle is well selected for that kind of investigation which the author has already shown that he knows so well how to carry out. The real nature of its components are by no means understood in spite of the researches of Gegenbaur[1] and others; yet their apparent simplicity tempts to speculation which has run easily into erroneous dogma. Mr Parker, in the execution of his task,

[1] *Schultergürtel der Wirbelthiere.* This admirable work, of which we gave a brief notice at p. 157, is the only one on the subject to be compared with the one before us. The compound nature of the bones of the shoulder-girdle is described; and the partly cartilaginous, partly fibrous origin of the clavicle in man is worked out more fully than by Mr Parker.

takes his stand upon morphology, using histology as a handmaid; at which indeed he tells us that he has worked hard, though space does not permit of the results being given. Teleology he leaves altogether out of consideration as not to his point, however interesting. Professor Huxley has been the 'man of his counsel' in many matters; and a better he could not have found, as the result proves. Nevertheless he does not prove a servile adherent to the views of that master. Though wishing to work peaceably, yet he remarks that "controversy was one of the exciting causes of this particular line of research;" and the tendency of his feelings, though no evil animus is shown, is somewhat evinced by the following note, which will rejoice the heart of many a weary student.

"I hope never again to use that mischievous word 'apophysis,' with its ninety-and-nine prefixes; it was a cloudy and dark day for anatomical science when the transcendentalists, 'with their enchantments,' brought this swarm upon the land." (p. 5.)

The *Troja caduca*—if indeed it can be said to be still standing—of the occipital relation of the fore-limbs *ruit*, we trust, entirely under the following thrust:

"I shall afterwards show *that there is no instance whatever in which the true Shoulder-girdle is articulated to the occiput.* All the confusion in this matter is due to Cuvier's misinterpretation of the first lateral-line bone (my 'post-temporal scale') as the supra-scapula; and on this *nail*, which could not be driven into Nature's hard wall of *facts*, our great English anatomist hung his theory of 'the Nature of Limbs.'" (p. 12.)

In a few introductory remarks the 'cartilaginous skeleton' is called the 'endo-skeleton,' and is divided into 'axial' and 'accessory,' "the limbs both root and branch belonging to the latter category." Ancillary to it is the 'fibrous skeleton' or 'exo-skeleton,' the skeleton of the skin and its infoldings.

"These two skeletons maintain their greatest independence of each other in the *oldest* and most generalised types of Fishes; in the newer (cycloid and ctenoid) types the correlation of the two becomes much more evident and perfect; but we must pass through all the cold-blooded vertebrates, and even past some of the lower types of the warm-blooded, before we see the greatest inter-dependence of these diversely developed structures." (p. 4.)

The ossifications of the skin constitute the ganoid plates, which in some animals form a coating or helmet more or less completely covering and masking the subjacent parts of the exo- and endoskeletal structure. These dermal plates are sometimes inseparable from the subcutaneous ossifications; sometimes they are less closely united; but both contribute to the exo-skeleton. The components of this fibrous exo-skeleton are, and it is an interesting fact, often correlated to those of the cartilaginous endo-skeleton. They may be merely applied or united to them by harmony, or they may be ankylosed; thus the interclavicle of Ostracion is ankylosed to the pre-

coracoid and joined by harmony to the coracoid (p. 35). On this point we have the following interesting paragraph:

"If I had surveyed these parts fresh from the typical Fishes they would have caused me much trouble; but the way has been made much smoother by my coming to them through by-paths. We have seen this coalescence of parts of the outer and inner skeleton, and shall see it again, and it is noteworthy that, although the splint-bones are ready enough to coalesce with endo-skeletal bones, yet, retaining their old nature as scales, they are very slow to combine with each other. The *affinity* of the dermal system for the endo-skeleton becomes stronger and stronger as we ascend the vertebrate scale; and in the warm-blooded classes the most remarkable metamorphic combinations take place." (p. 35.)

The ossification, which commences in the intercellular substance of hyaline cartilage, is called 'endostosis.' This is sometimes confined to the surface and then is 'superficial endostosis.' The ossification in the almost structureless layer of perichondrium, in immediate contact with the outermost cartilage-cells, is named 'ectostosis,' and that in the skin, the subcutaneous fibrous mesh or the aponeurotic tracts, 'parostosis.'

"All these modes have to be most carefully traced backwards to their earliest appearance, otherwise the study of osseous centres is most perplexing; for one of the constant results of ossification in the higher classes is the coalescence of parts morphologically separate." (p. 4.)

This, then, is one of the first difficulties to be mastered, in order to obtain a correct knowledge of the real nature of the several parts of the shoulder-girdle, or indeed of any other division of the osseous fabric; and the reference of these parts, respectively, to their endo- or exo-skeletal origin can be correctly done only by embryological investigation and by comparison of the corresponding parts in different animals.

The latter is the line chiefly taken in this book. The author keeps strictly to the description of what he has seen, and describes the structures in an ascending manner from the lower vertebrate type to the higher. He commences accordingly with the Placoid Fishes, in which there are no splints, the shoulder-girdle being entirely cartilaginous and forming, therefore, a grand starting-point for investigation. In Raia clavata the shoulder-girdle consists of a scapula, a distinctly segmented supra-scapula, and a coracoid. The scapula, descending from its joint with the supra-scapula, breaks into three bars—the 'præ-,' 'meso-,' and 'post-scapular' regions. These are continuous with three parts of the coracoid—the 'præ-,' 'meso-,' and 'post-coracoid' (the latter being the coracoid proper)—which are united beneath. At the insensible lines of union of the scapular and coracoid portions are three glenoid facets. The portions or bars are separated by fenestræ—a 'scapulo-coracoid' fenestra in front, between the two anterior bars of the scapula and the coracoid, a 'scapular' fenestra between the two hinder bars of the scapula, which is separated from the third—the 'coracoid' fenestra—situated beneath it,

by a transverse bar of cartilage connecting the second and third glenoid facets. The coracoids of the two sides are united together by 'epicoracoids,' forming a strong continuous transverse bar. The scapula and coracoid are Owen's radius and ulna: the 'brachials' attached to these are his 'carpals.' The fenestræ are the result of segmentation in the coraco-scapular plate. A greater degree of segmentation would cause a notch or open fenestra, and a still greater a division into separate parts.

This constitutes a typical or complete cartilaginous or endo-skeletal shoulder-girdle. As we ascend, the supra-scapula soon ceases to be segmented, and other parts—'dermal splints'—derivatives from the fibrous or exo-skeleton, are superadded to and applied upon the cartilaginous structure. Such in the Sturgeon are a 'post-temporal' (the supra-scapula of Cuvier and Owen), a 'supra-clavicle' (the so-called scapula), a 'clavicle' (Owen's coracoid), and an 'inter-clavicle.' All these four are, in this instance, more or less ganoid or cutaneous in addition to being the result of ossification of the subcutaneous fibrous or aponeurotic strata.

To these are added in Polypterus an 'upper' and 'lower *post*-clavicle,' forming a second row, the counterpart of which is the second 'lateral line' bone, or second thoracic-dermal cincture in Teleostei; as the first lateral line and the first thoracic-dermal cincture are the counterparts of the 'post-temporal' (supra-scapula) and the clavicular series. In Ostracion there is in addition a 'præ-clavicle,' extending from between the supra-clavicle and the clavicle across to the basis cranii. There are therefore in this fish seven exogenous bones, built above, below, and around the true endogenous shoulder-girdle, viz. 'post-temporal,' 'supra-clavicle,' 'præ-clavicle,' 'clavicle,' 'inter-clavicle,' and two 'post-clavicles.' In Syngnathus the inter-clavicle is divided into an 'anterior' and 'posterior inter-clavicle.'

The 'post-clavicles' constitute the more or less elongated faintly curved styloid appendages to the shoulder-girdle, of which various, but none very satisfactory, views have been taken by preceding anatomists.

The modifications of these several parts in the different Ganoids and Siluroids (recent and fossil), and others, up to the typical Teleosteans, the varying degrees of segmentation of the cartilaginous or true element of the girdle, the modes in which it is over-ridden or embraced, and sometimes almost extinguished by the exo-skeleton, the relations of the latter to the cutaneous envelope or dermal cinctures and to the components of the cranium, are all traced in detail with much careful description, and in a comprehensive, masterly, and, therefore, highly interesting manner. We are also shown how (Pl. II. figs. 12 and 13, Cottus and Gobius) the 'brachials' are formed by longitudinal segmentation and ectosteal ossification of the plate of cartilage lying next to the scapula and coracoid, and how by transverse segmentation the five horizontal brachial bars of Clupea harengus (fig. 4) are made into a double series.

In the AMPHIBIANS we revert to a cartilaginous, and therefore simpler, condition; for in them, as in the Rays and Sharks, no splints or *parosteal* growth is borrowed from the skin and its infoldings. There is the one plate of cartilage in which the 'supra-scapula,' 'scapula,' 'coracoid,' 'præcoracoid,' and 'epicoracoid' are distinguishable. Ossification, chiefly *ectosteal*, commences in the scapula, and follows in the coracoid and præcoracoid, forming three separate bones which approach and unite with one another in the glenoid cup. The epicoracoids come to overlap in the middle line to a considerable extent, the left overlapping the right and *vice versa* in the same family; and between the two posteriorly, in all perhaps but Proteus, and it may be one or two others, is received the small cartilaginous sternum which is so constant a correlate of the shoulder-girdle in air-breathing vertebrates. It belongs to the first dorsal vertebra and perhaps to the first cervical: and its presence in these animals is general although the rest of the costal arch is wanting.

"It may help comparison to remark that this first tract of cartilage, which lies directly behind, *within*, and mesiad of the epicoracoid angles, corresponds to the anterior half of the human 'manubrium sterni,' which is, in reality, the keystone, in us, of the seventh cervical vertebra. The side-walls of this seventh somatome, and also of the six preceding somatomes, are deficient in cartilage; the ribs, in the cartilaginous stage, never being segmented off from their centrums, as they are in the thoracic region. And this is one reason why the Shoulder-girdle has been confounded with the costal girdles; for, lying in front of these latter hoops, and being the only cartilaginous bars interposed between the skin and the space containing the œsophagus and trachea, they have been supposed to lie in the same plane as the ribs. Wherever the limb-plates are coincident, vertically, with the costal arches, they and their muscles always overlap, or lie in an outer *transverse* plane." (p. 80.)

The several stages of formation of the shoulder-girdle are traced with great care in Rana temporaria from the tadpole state. It is there one plate of cartilage with the upper point—the supra-scapula—corresponding to the intercentrum between the second and third vertebra, and having no more relation to the occiput than the same part in osseous fishes. In the middle is the massive glenoid part with the cup. Internal to this the cartilage is cleft by the coracoid fenestra which is bounded by the præcoracoid in front, the coracoid behind, and the epicoracoid internally. Ectosteal ossification begins in the coracoid and præcoracoid as well as in the scapula and supra-scapula. The anterior extremities of the præcoracoids project forwards, become segmented from their bases, coalesce, ossify, and form the 'omo-sternum,' which is therefore no part of the sternum at all, but part of the shoulder-girdle. Intercellular or endosteal bone crops out. The coracoids in process of development gain upon the præcoracoids. As for the ectosteal sheath of the latter,

"This is its last appearance on the great Vertebrate stage of life; the præcoracoid is dying out in the ascending scale of the Frog's specific and individual history, and, as far as my observation extends, no creature

with an *amnion* and an *allantois* in its embryonic condition has this particular ectosteal sheath; for when the cartilaginous bar itself is ossified from without, as in the Chelonians and *Struthio camelus*, it is by a borrowed extension of the scapular sheath." (p. 82.)

We are ever tempted to quote, and must yield again.

"I may here remark that the Sharks and Skates (Plagiostomi) shed the same light on the Amphibia that the latter throw on the higher Vertebrata (the Sauropsida and Mammalia), which possess an amnion and an allantois in their embryonic condition, and which pass through their metamorphic stages at a more and more rapid rate. The earliest metamorphic conditions of the higher classes are miniatures seen for a moment; those of the Amphibia are half-sized pictures, which are held up to view for weeks and months; but in the low Cartilaginous Fishes we see gigantesque figures which are never taken down. Hence the necessity for both 'gradational' and 'developmental' morphology; and these two divisions of one science are nothing if not mutual; for neither is development to be studied without gradation, nor gradation without development, but both must be worked out by the same observer, and the results of both must intermarry in the same intellect before that birth of thought can take place which can be called perfect science. I shall have to refer to the Amphibians again and again in describing the structure of the nobler antitypes which they in sundry ways foreshadow." (p. 83.)

Not till we come to the Blind-worm (*Anguis fragilis*), of which limbless scincoid a full description is given, do we find splint-bones after leaving the Fish. In this animal they form a long sigmoid 'clavicle,' and an 'interclavicle' strapped upon the antero-inferior part of the præsternum. The interclavicle has been described by Rathke and others as an 'anterior sternal bone,' and has long "blinded the eyes of the wise."

In the highly complicated shoulder-plate of the Iguana, which is the most perfect among the typical Lacertilia, we are carried back, so far as the endoskeleton is concerned, to the typical cartilaginous girdle of the Ray. Undivided above as 'supra-scapula,' it is beneath hacked in four fenestræ—'scapular,' 'coraco-scapular,' 'upper' and 'lower coracoid'—separated and bounded by the following belts:—'præscapular,' 'meso-scapular' (or acromion), and 'scapular,' 'præcoracoid,' 'meso-coracoid,' 'coracoid' and 'epicoracoid.' To these are added the clavicular splints extending from the base of the supra-scapula to the middle line. The latter meet above the azygos intraclavicle[1], to the transverse bars of which they are fixed.

The Chameleon and Crocodile, on the contrary, present an extremely simple shoulder-girdle—a scapular and a coracoid bar united at the glenoid cavity in an obtuse angle, with a cartilaginous 'suprascapula' and slightly developed 'præ-' and 'epi-coracoids;' the only trace of a splint being a small 'interclavicle' in the Crocodile. In the Chelonian also the true girdle corresponds with and resembles the forked ray of the Amphibian: the main part is the scapula with

[1] This is also a splint-bone—an interclavicular keystone—and therefore quite a distinct element from the 'omosternum' of the Frog, though occupying nearly the same position, and, like it, called 'episternum' by other authors.

an unossified supra-scapula in relation to the last cervical vertebra, the front fork is the præcoracoid, the hind fork is the coracoid; but the intercoracoid space is open. The clavicles and the interclavicle are, however, not wanting in the Chelonian; but they are separate from the girdle, and declare more obviously their dermal character by forming the fore part of the plastron, just as in the ganoid Callichthys they contribute to the formation of the outer dermal cinctures of that fish.

Mr Parker tells us that his researches into the nature of the BIRD's sternum commenced twenty-five years ago;—"And many a struggle have I had with its difficulties, as again and yet again I have returned to it." (p. 143). These difficulties are partly owing to the extreme rapidity with which the endosteal tracts grow in the Bird,

> "And thus a certain nick of time has to be found in which their distinctness may be seen; moreover, soon after the fast-growing fledgling of an Aerial Bird has taken to its wings the ectosteal layer commences, ultimately giving the bone as complete a *finish* as is seen in the Sternum of the Ostrich and the Fowl." (p. 145.)

He describes it as made up transversely of three regions, as in Man, —a 'præ-,' 'meso-' and 'ziphy-sternal'—and of five longitudinal parallel regions—'lateral,' 'intermediate,' and 'mesial'—the last being double in reality. Of ossifying centres the Struthionidæ (except Rhea) have but one symmetrical pair—'pleurostion'—related to the costal margin, as in Lacertilia and Crocodiles. In nearly all other birds there is a larger azygos centre—'lophosteon'—in the crest of the sternum. This, as well as additional centres, observed in certain birds, and denominated 'urosteon' and 'coracosteon,' are, he believes, absolutely ornithic, having no counterparts in other vertebrata.

With regard to the shoulder-girdle the transverse segmentation between scapula and coracoid is complete in all except the Struthionidæ; and in all the supra-scapula is ossified continuously from the scapular shaft and the epicoracoid from the coracoid. The precoracoid is segmented from the head of the coracoid and the mesoscapula (acromion) from the scapula. These segments are attached to and apt to be fused with the clavicles. The furcula consists of the clavicles and the small wedge-shaped interclavicle: "But that compound bone *adopts* the cartilaginous segments, as though they originally belonged to it; and from this arises the great difficulty of comprehending its true nature." (p. 143.) In the Ostriches a greater simplicity of parts prevails; indeed we have the simple characters of the Chelonian shoulder-bones back again—an unsegmented coracoscapula bifurcating below into a 'præcoracoid' and a 'coracoid.' In Rhea and Apteryx the parts are simpler still; a mere bar of scapula and coracoid with only a slight projection to mark the præcoracoid. This in the Cassowary and Emeu runs out a little further, and bears a small clavicle upon its front.

In the curiously aberrant lowest class of MAMMALS—the almost oviparous Monotremes—the reptilian characters of the Shoulder-girdle

appear again in its form, its imperfect segmentation, its coracoid and ectosteal epicoracoid, its fenestra and its præthoracic dermals—the clavicles and the large T-shaped inter-clavicle. As for the Shoulder-girdle of the other mammals, impossible as it might seem, our insatiable investigator contrives to point out in it the various elements that have been introduced to us in lower animals, or most of them, in lessening masses, it is true, but often with higher metamorphic grade. The scapular has its more or less developed supra-scapular margin, its—'præ-scapula,'—separated from the coracoid by the suprascapular notch or a coraco-scapular fenestra. It has also its 'meso-scapula' or acromion with a meso-scapular segment at the scapular end of the clavicle, and its 'post-scapular' or posterior part. Nothing daunted at the coracoid difficulties he traces, in addition to the coracoid in its usual place, a 'præcoracoid' in the cartilaginous sternal end of the clavicle, a præcoracoid segment[1], answering to the 'omosternum' of the Tadpole, at the clavicular margin of the sternum (it is the meniscus in man), and a spindle-shaped 'epicoracoid' in the axil of the first costal cartilage with the sternum. There is however no 'inter-clavicle.'

We have given only some of the results and only alluded to the vast amount of detailed investigation of the step-by-step stages of anatomical structure, upon which they are based. Enough however has been given to show that this is no ordinary work, but such a collation of facts, suggesting and substantiating views as will raise the character of the science it represents and will gain for itself a sure place among the enduring tomes of anatomical literature.

Handbook of the Sphygmograph. By J. BURDON SANDERSON, M.D., F.R.S. London, Hardwick, 192 Piccadilly, 1867.

That physiology must be the basis of the science of medicine will be generally admitted; and the improvement in the modern methods of clinical research is daily proving more clearly the close relation that exists between physiology and the practice of medicine, and is therefore bringing the latter more and more within the legitimate range of science, at the same time that it is conferring more precision upon it. This truth has found its expression and, we hope, its furtherance in the foundation of the new Clinical Society, and has a good illustration in the introduction of the Sphygmograph, and in the present treatise upon it. By bringing the phenomena of the pulse, and their variations in disease, more definitely under the cognisance of the eye, and stamping them with precision upon paper, the Sphygmograph has necessitated a more close investigation of the nature of these phenomena and of their causes; forasmuch as an appreciation of the real significance of their variations in disease must depend upon a knowledge of their character and

[1] This derivation of the coracoid in some Rodents was recognised by Gegenbaur, *l. c.* § 3.

causes during health. We are probably not far wrong in surmising that the sphygmograph was the suggestor, one of the suggestors at any rate, of the Clinical Society; and we know that the author of this 'Handbook' was one of the chief originators of the society. He has given ample proofs of his powers of investigating and appreciating physiological phenomena; and we have good reason to anticipate that in the hands of himself and his colleagues, the new society will be an active means of making the physiological interpretation of closely observed clinical facts a pathway to a surer and better system of therapeutical action.

Dr Sanderson wishes his 'little book' to be regarded as merely 'a guide', a 'grammar of the sphygmograph', and offers it to his fellow-workers 'in the hope that it may help them to overcome those preliminary difficulties which are apt to be encountered in the application of any new method of research.' He expressly states that it makes 'no pretension to be regarded as a physiological treatise;' but however simple and practical he would be, he finds it necessary, we are glad to say, to deal to some extent with physiological theories.

"In every arterial pulsation four events are to be distinguished. 1. *The sudden primary expansion of the artery.*" 2. "*The systolic distension,*" by which appears to be meant the distension of the arteries remaining after the ventricle has ceased to contract. It is indicated by the arched line with the concavity downwards in sphygmographic tracing, and has a relation to the quality of the pulse usually called *fulness*, being entirely absent in many varieties of feeble pulse. 3. "*The diastolic collapse.*" 4. "*The diastolic expansion.*" This, which has been long recognised as communicating to the pulse in adynamic fever a special character, that of dicrotism, has occasioned much speculation as to its cause. Dr Sanderson attributes it, if we follow him correctly, to a retardation in the capillary circulation consequent on the relaxation of the capillary arteries during the diastole, "while the aorta becomes simultaneously distended in consequence of the increased resistance in front. This distension is in turn propagated towards the periphery, and is succeeded, like the systolic distension, by collapse," p. 23. To this it seems natural to object that the relaxation of the capillaries and the retardation of the circulation in them are consequent on a corresponding condition of the aorta and other large arteries, and can scarcely lead to a distension of them. Such an effect might be induced by a contraction of the capillary vessels following upon their sudden distension under the systole, and producing a counter-shock, or recoil, in the arteries travelling in an opposite direction to that of the shock caused by the systole. To such a cause we have always felt disposed to attribute the second or diastolic expansion of the arteries; and such an explanation seems to accord with the circumstances under which dicrotism is most observed, viz. where the development of the first or systolic distension is sudden though least complete and prolonged.

A wise warning is given against too great hurry in introducing "the sphygmograph into the consulting-room; for if, with so imperfect

a knowledge as we at present possess of first principles, we endeavour to use those principles in diagnosis, we shall not only discredit ourselves, but the method by which we profess to be guided."

The following remarks on the mode of action of the heart may well be quoted in extenso.

"A number of facts seem to make it probable that, *whenever the heart contracts of itself*, i.e. *automatically, it contracts gradually and peristaltically, its constituent fibres being brought successively into action; and that, in so far as the movement is deprived of its automatic character by the influence of stimuli acting through the spinal cord, it becomes sudden and instantaneous.*

"Sphygmographically, suddenness of contraction manifests itself in verticality and amplitude of the primary ascent of the tracing; while in those forms of pulse which correspond to a more gradual mode of contraction, the first event is indistinguishable. Hence we are led to associate absence or suppression of the first event with all those conditions of the circulation in which the heart may be supposed to act automatically; and to believe that, whenever the artery expands sharply under the finger at the moment of the shock of the heart—whenever, in short, the first event becomes a prominent feature of the tracing—we have evidence therein that the systole of the ventricle is no longer peristaltic, but reflex; and that, through the spinal cord, influences are at work (whether originating from emotions, sensations, or abnormal constituents in the blood) which are not altogether normal. In all such cases, a sharp sound, having the character of the second sound, is heard on auscultation in the neighbourhood of the præcordial impulse." p. 29.

All workers with the sphygmograph, i.e. all accurate clinical observers, and all who desire to understand the physiology of the circulation, must read and reflect over the 'Handbook of the Sphygmograph.'

Du Mouvement dans les Fonctions de la Vie, par E. J. MAREY, Prof. Suppléant au Collége de France. Germer Baillière, Paris.

In publishing his course of lectures delivered at the college of France, M. Marey has made a valuable contribution to experimental physiology. The book has the faults and the excellences which usually characterise courses of lectures when published. On the one hand we have a good deal of superfluous matter concerning the connection of the sciences, the part played by analytical and synthetical methods, and the advantages of the graphical representation of movements; while on the other, there is great clearness in explaining the methods and the mechanism employed, and great precision in the statement of the results obtained.

M. Marey is already known to the scientific world, not only by his works on the circulation of the blood, &c., but as the improver of the Sphygmograph, and the myographic vice. He seems to have that rare combination of tact in experimenting and logical power, as applied to biological science, which so distinguishes our Prof. Tyndal in physical investigations. The author, with a natural bias in favour of his branch of the subject, assumes, perhaps on too slight grounds,

that all vital actions, or all the more important vital actions, depend on the contractibility and elasticity of tissues. He accepts the dictum of Bernard: "Muscular movement constitutes the principal animal function, and therefore the muscular system is the centre of the phenomena manifested by living beings." Muscular fibre is the tissue which, par excellence, is endowed with contractility and elasticity, and hence the study of the manifestations of these by the muscles may be taken as typical. In order to determine the amplitude, duration, and form of muscular contraction under different stimuli, a mechanism is employed, which, though necessarily somewhat complicated, is as simple as is consistent with obtaining correct and distinct graphical records.

The results are important as confirming what has been already determined or conjectured relating to muscular contractions, rather than as contributing any thing fresh to our knowledge.

The examination by the graphical method of the muscular contraction produced by a single excitement (i. e. *secousse*), shows that no typical representation can be obtained, owing to the variations occasioned by the length, nature, temperature, state of fatigue, or of previous repose, of the muscle operated on. The muscular shocks (if we may so translate the word *secousse*) occasioned by striated fibre are brisk, both in contraction and relaxation, and those of smooth fibre prolonged. By lowering the normal temperature the length of time occupied by the muscular contraction is much increased, but the amplitude is at first slightly augmented. Fatigue has a very similar effect, but it is manifested much less rapidly, heat curtails the duration of the shock, and at first slightly increases the amplitude; but if it be further increased, this is diminished by the incipient coagulation of the muscle. Many other experiments are given which illustrate the influence of different conditions on the muscular contraction.

A new field for exploration is opened to the zoologist by the observation of the character of the effects of the excitement of the muscles of different animals. Thus, the duration of the contraction occasioned by an electric shock in the muscles of a turtle is sixty times as long as that of a bird. In operating upon a marmot in a state of hybernation, according to the first indications, the duration of the contraction was as long as that of the muscles of a turtle, but as the experiment proceeded and the animal was aroused, the contraction became more and more rapid, until the experimenter was obliged to desist, because, as he remarks, a wild marmot is not a very manageable animal.

From a correct observation of the phenomena exhibited by the single excitement, or shock of contraction, which may be considered as the simplest element of the complex function of the permanent contraction of the voluntary muscles, it is easy to pass to the investigation of the phenomena of multiple shocks. These being repeated in more and more rapid succession interfere with one another, and finally cause the contraction to be completely blended, so as to produce perfect tetanos.

Without following out the interesting details of the modification of this artificial tetanos produced by different means, but mainly by the use of the more manageable agency of electricity, it is sufficient to state that the minimum numbers of simple contractions which will produce complete fusion of their effects in the voluntary muscles is determined to be 27 per second.

This artificial tetanos is considered to be an exact reproduction of the permanent contraction of the muscle produced by the exercise of volition. In other words, the apparent immobility of a contracted muscle masks the effects of a series of rapid vibrations or influences conveyed by the nerve from its centre. The number of shocks required for complete fusion accords well with the previous determinations of Weber and Helmholtz. They both assign to a contracted muscle thirty-two vibrations per second, and this number agrees with the vibrations indicated by listening to the tone produced by the masseter muscle when the jaws are locked and the ears stopped with wax.

The mechanism which occasions the fusion of the successive influences is supposed to be the following. Each ultimate muscular fibre under the influence of a shock is shortened by the swelling of that fibre, but the swelling occupies only a portion of the entire length of the fibre and travels as a wave along its whole length, and so is propagated to the next. When, however, the shocks are so rapid as that the influence of the one has not passed from an ultimate fibre until another reaches it, permanent contraction is the result. The graphic method can reveal that such a wave exists and estimate its rate of motion.

Muscular elasticity is quite a different property from contractibility, but equally necessary and important. It may be generally stated that the elasticity of organized tissues differs from that of unorganized substances in the following particular. If, in experimenting on both, within the *limit of their elasticity*, we give a graphical representation of each, so that the abscissa represents the tension and the ordinate the elongation, then the diagonal of the inorganic substance will be a straight line, while that of the organized tissue will be (approximately) a hyperbola. The elasticity and extensibility of a muscle is effected by its state of contraction. The greater the contraction the greater the extensibility. M. Marey shows by an ingenious but simple scheme, that, contrary to a *prima facie* supposition, the elasticity of a muscle is favourable to the production of work.

Some interesting experiments are given which bear on the rapidity of transmission of the nervous agent, and also on the effects of strychnia and curara on the nerves; but the speciality of the volume is the investigation of the function of the voluntary muscles by synthetical and graphical methods. As a clear exposition of the methods hitherto employed, and the condition of our knowledge on this interesting subject, its value is great.

M. Marey manifests a laudable desire to place all experimenters in this branch of science 'en rapport' with one another, by determin-

ing the details of the rate of motion of the recipient, the amplitude of the contraction, &c., so that the graphical results of all experimenters may be compared, which now is quite impossible. The difficulty in adopting a fixed standard in these matters is however clearly shewn by M. Marey himself, who has been compelled, in the course of his numerous and ingenious experiments, to adopt new and better methods, although their adoption frustrates the desire he has so much at heart, of co-ordinating his results with those of previous observers.

NEVILLE GOODMAN, *Pet.*

Die Nerven-Varietaten beim Menschen von W. KRAUSE und J. TELGMANN. Leipzig, Verlag von W. Engelmann, 1868.

The authors have collected together and arranged the varieties in the nerves of the human body observed by themselves and others, showing that such varieties are not so infrequent as have been supposed, though they are rare in comparison with the varieties of arteries and veins. The interest which may attach to a careful study of them in relation to the functions of the nerves, and more especially of the cerebral nerves, is obvious; and the present short treatise will serve for reference to those who are desirous of following out this subject.

Die Anatomie des Kaninchens in topographischer und operativer Rücksicht, bearbeitet von Dr W. KRAUSE, Professor in Göttingen. Leipzig, Verlag von W. Engelmann, 1868.

This is a complete and careful monograph on the anatomy of the Rabbit; its accuracy we have in many instances verified by dissection.

Researches in Obstetrics. By J. MATTHEWS DUNCAN, A.M.M.D. Lecturer on Midwifery, &c. Edinburgh, Adam and Charles Black, 1868.

This is not a mere practical book in Midwifery; it contains much interesting matter on the Physiology and Pathology of Pregnancy and the Puerperal state; for instance, on the Position and Direction of the Uterus during pregnancy, the Development of the Pelvis, and the Position of the Fœtus. The last, after much discussion, is attributed, with insufficient reason as it appears to us, to gravity. We should have thought a better explanation was afforded by Dr Duncan's own drawing (fig. 5, p. 26), which shows the natural physical adaptation of things to be, that the trunk and limbs, constituting the larger part of the fœtus, should occupy the fundus or larger more distensible part of the uterus; and that, consequently, the head becomes placed in the lower, less capacious region. In the part on the 'Pelvis studied with a view to obstetrics,' Dr Duncan is at some

pains to show that the 'sacrum is not a wedge' and that it is 'not a keystone.' That it is however a wedge there can be no doubt; and what is meant is 'that it does not act in any important respect as a wedge.' True, it is not dependent upon its wedge-shape to support the weight of the body. Nevertheless in one direction in which forces are received, viz. from behind forwards and upwards, in the propulsion of the body by the lower limbs, the sacrum does act in an important respect as a wedge, resisting the forward displacement of the iliac bones and so giving security to the spine during this movement. In most of the lower animals the wedge-like construction of the sacrum for this purpose is very obvious.

In objecting to the application of the term 'keystone' to the sacrum Dr Duncan does not define what is meant by a keystone. If, as seems to be generally admitted in architecture, the keystone is the topmost bone of the arch without respect to shape—it may be a square or a parallelogram or a wedge, as it usually is, or an inverted wedge—then we apprehend the sacrum does fulfil this one requirement, and, whatever may be said to the contrary, it is the 'key-bone' of the pelvic arch. That its surfaces are uneven or 'joggled,' and that it owes its security not a little to this joggling, by no means militates against its being a 'key-bone,' forasmuch as the 'keystone' and other stones of an arch are often joggled for the like purpose of increasing the resistance to their displacement. Just as it was maintained at p. 188 of Vol. I. of this Journal that the fact of the astragalus not being the centre bone of the plantar arch does not prevent its being the key-bone of that arch; so it may be held that the peculiar shape, &c. of the sacrum do not prevent its being the key-bone of the pelvic arch.

These, however, are not points of much importance and do not invalidate the practical value of the work.

Outlines of Physiology Human and Comparative. By JOHN MARSHALL, F.R.S. Longman and Co., 1867.

This does not profess to contain original matter but to be an educational book; and a very good one it is, giving an excellent resumé of what is known in a clear, agreeable manner. It might, we think, have been compressed with advantage from two volumes into one, by the omission of some of the anatomical details which are to be found in ordinary handbooks of anatomy, and by a little more economy in the recital of the various views upon many of the subjects.

Handbuch der Systematischen Anatomie des Menschen. Von PROFESSOR HENLE. 3rd Vol., 1st part. Gefässlehre, Brunswick, 1868.

In this part of his most important systematic treatise on human anatomy, Professor Henle gives a description of the heart, arteries,

veins and lymphatics, and intercalated in the text are 180 excellent woodcuts, many of which are coloured. The subjects treated of in this part do not furnish so many novelties as in those divisions of the work in which the anatomy of the viscera and sense-organs were considered. The disposition of the muscular fibres of the heart has however been carefully investigated, and as his description differs in many particulars from that arrangement of the fibres in layers, varying in direction from without inwards, which Dr Pettigrew has given in the *Phil. Transactions*, we summarize it. Thus he considers that the ventricular fibres are arranged in plates or lamellæ, placed one over the other, with one edge directed inwards, the other towards the exterior of the wall. The direction of the surfaces of the plates varies. Throughout the septum, they are nearly horizontal; as is the case also in the ventricular wall midway between the base and apex; above and below the middle the surfaces of the plates are oblique, slanting from within downwards and outwards towards the apex, and from within upwards and outwards towards the region of the auriculo-ventricular ring: the obliquity gradually increasing, so that near the apex and near the ring the surfaces are vertical. The plates form imperfect rings surrounding the ventricular cavity, and in the upper part of the wall lie at right angles to the axis, as they descend they become oblique and elliptical. They are connected by fine areolar tissue and intercommunicating fibres, and merge into each other at different points, or diminish in size and cease. The latter is especially the case towards the apex, and causes the decrease in the thickness of the ventricular wall in that locality.

The author has entrusted to his colleague, Prof. W. Krause, the description and systematic arrangement of the manifold variations in the arterial and venous systems, which have been recorded by various anatomists; in the preparation of which he has profited largely by the industry of those who have preceded him in the same line of enquiry, and is especially indebted to the information contained in the systematic writings of Meckel, Otto, Tiedemann, Quain and Dubrueil. In his arrangement of the variations in the pulmonary artery, arch of aorta and primary branches of the arch, Krause has adopted the method of classification based on embryology, which Prof. Turner had previously employed in his memoir in the *British and Foreign Medico-Chirurgical Review*, July and October, 1862. He has also, with some slight and unimportant modifications, copied the diagrams based on Rathke's idea of the mode of development of the vascular arches, with which Turner had illustrated his views on this subject. But though making free use of the classification and the diagrams, to which he was of course fully entitled, he has omitted all reference to the source from which he had derived them, and has laid himself open to the charge of having committed a grave literary fault and act of injustice towards a scientific *confrère*. To prove that we are not pronouncing a harsh judgement on Krause, we have simply to ask our readers to compare Krause's divisions and subdivisions, p. 212, with those employed by Turner, when it will be seen that the words

of the latter are simply translated, and in various other parts of the description, though Krause may not have given a mere verbal translation, yet he has adopted without acknowledgment the explanations advanced by that anatomist, and announced them as if they were his own. That the resemblance indeed, between his mode of treating the subject and that previously employed in the memoir already referred to, is not a mere accidental coincidence, but is due to an acquaintance with it, is shown by the fact that in some of his descriptive details he refers to it more than once in connection with several of the cases therein recorded. It is much to be regretted, that this otherwise excellent summary of the variations in the arterial system should have been disfigured by this act of plagiarism. We fully absolve Prof. Henle from all blame in this matter, for that distinguished anatomist is especially careful on all occasions to acknowledge the sources whence his information is derived, and we doubt not when his attention is directed to the subject, that the necessary corrections will be made in the succeeding editions of this volume.

Die Nerven der Gebaermutter und ihre endigung in den glatten muskelfasern. By Dr F. Frankenhaeuser. Jena, 1867.

This elaborate treatise on the nerves of the uterus, and their mode of termination in the smooth muscular fibres of that organ, is the most important contribution which has yet been made to this obscure and difficult department of anatomical enquiry. The author begins with a chapter in which he describes the history of the subject, more especially with reference to the writings of Wm. Hunter, Tiedemann, Robert Lee and Snow Beck. He then relates his dissections of the great cœliac ganglion, and of the various abdominal ganglia and plexuses of the sympathetic system and of the cerebro-spinal nerves, connected with them, and afterwards proceeds to consider the distribution of the nerves to the ovaries, uterus and vagina. His dissections were made on the fœtus at various stages of development, on new-born and older children, on unmarried girls after puberty, and on pregnant and non-pregnant women.

He gives a careful description of the large cervical ganglion of the uterus, which Lee has especially directed attention to, and he confirms the existence of the vesical ganglia of the same anatomist, but denies the presence of his sub-peritoneal ganglia. The uterine nerves are mainly derived from this cervical ganglion. They lie in the connective tissue which surrounds the fasciculi of muscular fibres, and they extend also between the individual fibres. He recognises four different kinds of nerve fibres in the uterus, opaque contoured fibres; pale fibres forming net works, which arise from the double contoured fibres; pale nucleated fibres, which arise either directly from the double contoured, or branch off from the pale fibres; extremely delicate, fine, pale fibres, presenting small swellings, which branch off from the pale nucleated fibres.

He traces the last description of fibre to its termination, and states that it ends in the nucleolus within the nucleus of the muscular fibre cell. In his account of the microscopic anatomy, he carefully considers the labours of Klebs, Beale, Henle, Kölliker and others, who have written on the minute structure of muscle and of nerve. As to the new formation of nerves during pregnancy, he has not yet come to a definite conclusion, for which indeed a large series of observations into the development of the nervous system would be necessary, but that an increase of the uterine nerves does take place in pregnancy there can be no doubt. The work is beautifully illustrated with eight folio lithographic plates.

On the Classification of Birds; and on the Taxonomic Value of the Modifications of certain of the Cranial Bones observable in that Class. By THOMAS H. HUXLEY. (From the *Proceedings of the Zoological Society*, 1867.)

This important paper contains in full the results of the researches of which an abstract was given in this Journal a year ago (Vol. I. p. 369), when the author communicated them to the Zoological Society. Further investigation has induced him somewhat to modify his views from what they were when first announced. His second Order, *Ratitæ*, is divided into five suborders, represented by (i) *Struthio*, (ii) *Rhea*, (iii) *Casuarius*, and *Dromæus*, (iv) *Dinornis* and (v) *Apteryx*. His Third Order, *Carinatæ*, is now divided by him as follows:

i. Dromæognathæ	ii. Schizognathæ	iii. Desmognathæ	iv. Ægithognathæ
1. Tinamomorphæ	1. Charadriomorphæ	1. Chenomorphæ	1. Cypselomorphæ
	2. Geranomorphæ	2. Amphimorphæ	2. Coracomorphæ.
	3. Cecomorphæ	3. Pelargomorphæ	
	4. Sphiniscomorphæ	4. Dysporomorphæ	
	5. Alectoromorphæ	5. Aetomorphæ	
	6. Peristeromorphæ	6. Psittacomorphæ	
		7. Coccygomorphæ	

The other family *Celeomorphæ* remains with its position at present undetermined, but it should probably rank under the *Ægithognathæ*. The family *Coccygomorphæ* also will most likely have to be further broken up into two or perhaps four families. Prof. Huxley defines all the groups he proposes with considerable minuteness; and as the paper is well illustrated by figures it forms one of the most valuable contributions to systematic zoology that has been published for a long time.

Remarks on Prof. Huxley's Classification of Birds, by ALFRED NEWTON. (From the *Ibis*, January, 1868.)

Prof. Newton, who, in November 1866, in a Lecture at Cambridge, stated the outlines of a classification of Birds with which, in its chief divisions, Prof. Huxley's new classification agrees, is of opinion that the articulation of the bones of the base of the skull does not afford a sufficiently wide groundwork for classification.

He shows how, for this reason, several of Prof. Huxley's definitions break down: for instance, the palatal characteristics of Ratitæ are precisely those in which they are indistinguishable from Dromæognathæ. Prof. Newton thinks that Prof. Huxley's sub-orders are, on the whole, natural groups, but that they are so independent of palatal structure. A satisfactory classification of birds cannot be based upon one bone, or set of bones, but must arise from the consideration of an aggregate of characters.

Nitzsch's Pterylography. Translated from the German for the Ray Society by W. S. DALLAS, F.L.S. Edited by P. L. SCLATER, F.R.S. 1867.

This book, now for the first time published in English, treats of the parts of feathers, of the kinds of feathers, and of the mode of growth of feathers throughout the class Aves. Feathers are of four kinds; Surface-feathers, Down-feathers, Semiplumes, and Filoplumes. These several kinds of feathers are distributed over the skin in definite tracts. The Penguin and the Cassowary are almost the only birds whose skin is completely covered with feathers. Nitzsch names nine feather-tracts and eight spaces. These tracts and spaces may be investigated either by clipping the feathers close, or by examining the inside of the skin.

Observationes de Avium arteria carotide communi, by C. L. NITZSCH, M.D. (Ray Society, 1867.)

This treatise is published in the volume with the 'Pterylography.' The carotid artery is, in Birds, either double (that is right and left from the very beginning and throughout), or simple at first, but with two branches, right and left, joining together, and then dividing again, or single and on the right side, or, lastly, single and on the left side only. The course and situation of the artery is the same throughout the class, some species of Parrots excepted. The carotid artery is double throughout in a large number of birds, as examples, the Goshawk, Goatsucker, Partridge, Bustard, Heron, Coot, Wild-duck, and Guillemot may be given. Nitzsch has only found the second plan in the Bittern, a singular deviation from the structure of its ally the Heron. A single carotid artery, and that the right, is found in the Flamingo. All remaining birds have but one carotid artery, and that the left; for example, Raven, Wagtail, Wren, Titmouse, Lark, Sand-martin, Swift, Hoopoe, Rhea.

Osteologia Avium, by T. C. EYTON (Wellington, Salop. 1867).

This book contains a very large series of good lithographs of birds' skeletons furnishing figures of nearly every remarkable form. Nothing like it has ever before been attempted. Considering the number of plates, it is not an expensive work to the purchaser, but we fear it must be so to the author, to whom the public should be greatly indebted for placing a book so useful at their service.

REPORT ON THE PROGRESS OF ANATOMY.

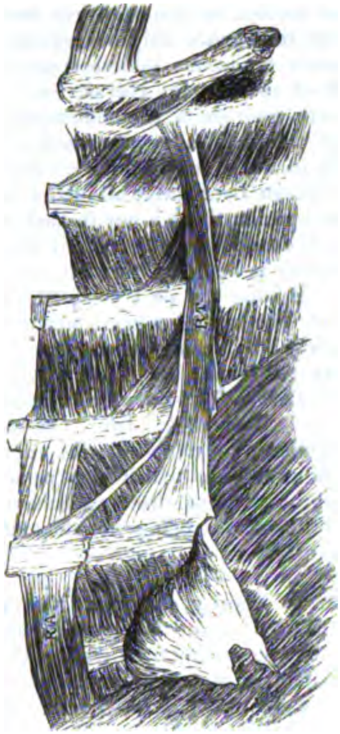
By Professor Turner[1].

Osteology. Dr Larcher communicates (*Robin's Jl.* March, 1868, p. 167) a history of the discussions respecting the presence of the Inter-maxillary bones in Man, in which he combats the opinion of Em. Rousseau, that these bones are not present in the normal state. He regards them as physiologically existing in the primordial state, although they may not be visible at the period of birth. Prof. Wenzel Gruber describes (*Virchow's Archiv*, Oct. 1867, p. 427) a full-grown human male fœtus in which the left Radius was rudimentary: the upper end was present and connected below to the carpus and ulna by a fibrous membrane. The metacarpal bone and phalanges of the thumb were wanting. The muscular arrangements were at the same time considerably modified.—— Prof. Hermann Meyer (*Reichert and Du Bois Reymond's Archiv*, Part v. p. 615, 1867) records his observations on the architecture of the spongy tissue of the bones.——Prof. Gegenbaur communicates to the *Jenaische Zeitschrift*, iii. Parts 1, 2, 3, important memoirs on the formation of bone. In one he discusses the formation of primary or secondary bones, more especially with reference to the doctrine of the primordial cranium; whilst in the other the formation of the tissue itself, and the relations of the lamellæ, corpuscles and fibres of Sharpey to the cartilage or connective tissue, in which the ossification occurs, is enquired into.—Gegenbaur also records congenital deficiencies in the clavicle occurring in the persons of a mother and her three children.

Myology. Since the publication by Prof. Turner in this Journal, May, 1867, of his observations on the Musculus Sternalis, he has described (*Proc. R. S. Ed.* Jan. 20, 1868) two cases in which a musculus rectus thoracis was found in the human subject. In each a longitudinal muscle lay in contact with the outer surface of the anterior extremities of the upper true ribs, and beneath the fibres of the pectoral muscle, which from the position, direction, and connection of its fibres, he believes to be homologous with the thoracic end of the mammalian rectus. Both subjects were males. In one a longitudinal ribbon-shaped muscle (R. T.) arose by a thin expanded tendon, from the upper border of the fifth left rib, immediately internal to the attachment of the serratus magnus. The innermost part of its tendon was continuous with the membrane covering the internal intercostal muscle, and was attached to the rib at the junction of its osseous and

[1] To assist in making this Report more complete, Professor Turner will be glad to receive separate copies of original memoirs or other contributions to Anatomy.

cartilaginous portions. From the anterior surface of the fourth rib, close to the origin of the serratus magnus, a second and smaller origin



proceeded. The muscle ascended superficial to the osseous parts of the third and second ribs, as high as the first rib, into which it was inserted immediately external to the tendon of attachment of the subclavius muscles. The muscle was six inches long and five-eighths of an inch broad at its widest part. The breadth of the fifth rib alone separated it from the upper attachment of the rectus abdominis (R. A.). A corresponding muscle existed on the right side. In the other subject, a longitudinal muscle—on the right side only—arose beneath the pectoralis minor from the upper border of the fourth rib two inches to the outer side of the junction of its bone and cartilage. It ascended superficial to the third and second ribs, to be inserted into the bony part of the first rib, three-fourths of an inch external to the attachment of the subclavius.

In the cat, the otter, the beaver, the porcupine, and various other mammalia, the rectus muscle extends as high as the first rib, into which it is inserted, and in this respect the arrangement may be compared with that of the occasional human muscles just described.

In these animals, however, the thoracic and abdominal parts of the rectus are directly continuous with each other, whilst in the human subject a break, corresponding in the first specimen to the fifth rib, and in the second, to the fifth rib and fourth intercostal space, occurred; but this break may be regarded as comparable to one of those transverse tendinous intersections, invariably found in the abdominal part of the human rectus, and which exist also in the recti of the greater number of the mammalia. These specimens seem to present as complete a representation of the mammalian arrangement, though in a somewhat different form, as is afforded by the case recorded by Kaau Boerhaave, alluded to in the former paper, and they support the opinion thrown out in that communication, that the supracostal muscle described by Mr John Wood (*Proc. Roy. Soc. London*, June 15, 1865), is homologous with the pectoral end of the mammalian rectus. During the past year, Mr Wood has described another specimen of the SUPRA-COSTAL MUSCLE (*Proc. Roy. Soc. London*, May 23, 1867) which passed from the third rib upwards to the first rib, and cervical fascia; Dr Roberts (*Liverpool Medical and Surgical Reports*, October 1867), one which extended from the fourth to the first rib; and Bochdalek, Jun. (*Virchow's Archiv*, 18th November 1867), under the name of M. supra-costalis anterior, has described and figured one, which also passed from the fourth to the first rib; but by none of these anatomists is any reference made to the probability of its being homologous with the pectoral end of the mammalian rectus.

NEUROLOGY.—M. C. Sappey describes NERVI NERVORUM (*Ann. des Sc. Nat.* VIII. 1867, p. 139, and *Robin's Journal*, Jan. 1868, p. 47), of extreme delicacy, but possessing both white substance and an axial cylinder in the neurilemma of the nerves, which are to the nerves what the *vasa vasorum* are to the blood-vessels. They are distributed not only to the common sheath of a nerve, but to the sheaths surrounding the secondary and tertiary fasciculi. They are absent on all the divisions of a nerve of which the diameter is not more than half a millimètre. The external fibrous envelope of the optic nerve receives a great number of branches from the ciliary nerves, but the internal fibrous envelope has no nervous filaments passing to it. Wenzel Gruber records (*Reichert and Du Bois Reymond's Archiv*, Part v. 1867, p. 552) the dissection of the right arm of a man in which the MEDIAN NERVE passed in front of the pronator teres, whilst the anterior interosseous artery, arising from the brachial above the elbow, pierced the muscle. He has also (p. 563) seen in the right arm of a boy and in both arms of a man the ULNAR NERVE prolonged downwards to the fore-arm in front of the internal intermuscular septum and inner condyloid eminence. In all the specimens the M. epitrochleo-anconeus was absent.—MM. Magnan and Hayem have communicated to the Micrographical Society of Paris, Aug. 6, 1865, (*Robin's Jl.* 1867, p. 107), an account of the INTERSTITIAL TISSUE OF THE WHITE MATTER of the nerve centres, which Virchow

had previously named *neuroglia*. This tissue is characterised by containing a large proportion of nuclei, more rarely cells, of a spherical or ovoid form, which are easily coloured by carmine. They lie in the direction of the nerve fibres and are not more numerous in the vicinity of the blood-vessels. They are almost equally numerous in all the different regions of white matter, except that in the spinal cord they are much less abundant. These nuclei correspond with those long since recognised in the grey matter, to which M. Robin has recently given the name of myélocytes.——Prof. Trinchese communicates a memoir ON THE PERIPHERAL TERMINATION OF THE MOTOR NERVES (*Robin's Jl.* 1867, p. 485), in which he advocates the view that at the extremity of the motor nerve fibres, a special structure (*plaque motrice*) is found under the sarcolemma, which is penetrated by the axial cylinder of the nerve fibre. This *plaque* is formed of two superimposed layers, a superior granular, an inferior homogeneous, the latter being probably nothing more than an expansion of the axial cylinder. It seems as if each muscular fibre had only a simple *plaque* the size of which augments in proportion to the size of the fibre. His views in the main agree with those of Kühne.——Julius Arnold continues his observations On the MINUTE STRUCTURE OF NERVE CELLS (*Virchow's Archiv*, XLI. p. 178). In the cells of the grey matter of the spinal cord he finds that fine fibres radiate outwards from their nucleoli through the nucleus into the substance of the cell which surrounds the nucleus, where they in part come into connection with the delicate lines which exist in this substance, and in part pass into the processes proceeding from it. Probably also a connection takes place between the homogeneous axial-cylinder-process of the cell and the nucleolus through an intermediate band. Many of the observations were made on perfectly fresh cords examined in pericardial fluid. The cells of the Gasserian ganglion usually possess two processes of which one has the character of a homogeneous axial cylinder process and is in connection with the nucleolus, whilst the other proceeds from the contents of the cell and winds specially around the first process. These cells are surrounded by a coat which consists partly of cells, and partly of homogeneous nucleated or non-nucleated layers. Similar layers also surround the nerve cells of the sympathetic.——The minute structure of the GREY MATTER OF THE CONVOLUTIONS OF THE CEREBRUM is described by Rudolf Arndt (*Schultze's Archiv*, III. 441, 1867). His observations were made on more than fifteen human brains, as well as on those of several animals, partly in the fresh and macerated condition, partly hardened in chromic acid, or chromate of potash, and coloured with carmine. He recognises five or even six layers in the grey matter. The first consists of fibres which mostly lie parallel to the surface, some of which are nerve fibres of medium size, others very fine varicose fibres, others naked axial cylinders, whilst others again are completely homogeneous, and are to be regarded as connective tissue. Between the fibres pale, round or oval, or irregular formed nuclei lie, and scattered black granules. Some of the fibres pass into the second

layer which consists mainly of *neuroglia*, in which pale irregular nuclei are scattered, and amongst these lie not only varicose fibres, but smooth fibres like those referred in the first layer to the connective tissue. These smooth fibres are connected with pale star-like cells also belonging to the connective tissue. Some of the nerve fibres are on one side connected with those of the first layer, and on the other pass into the deeper layers, whilst others form arches the convexities of which are directed towards the periphery. The first and second layers together correspond to the first layer described by Kölliker. The third layer presents, imbedded in the neuroglia, round, elliptical or three-cornered nerve-cells with one or more processes proceeding from the angles; one process stronger than the rest is usually directed towards the periphery. Large opaque-contoured nuclei often collected in heaps, and invested by neuroglia, also occur in considerable numbers. Nerve fibres traverse this layer in all directions, many of which are broad and double contoured, and form arches having their convexities turned towards the surface. The fourth layer presents numerous small ganglion cells each of which sends a delicate process towards the periphery. These cells are collected together into irregular masses. The third and fourth layers together correspond to the 'pure grey layer' of Kölliker. In the fifth layer the largest of the cells of the grey matter are found. They lie most abundantly in its upper and middle part, whilst nearer the white matter of the convolution small cells and opaque regular nuclei are found in greater numbers, from which circumstance this latter region might be distinguished as a sixth layer. The large ganglion cells are irregularly oval, pear-shaped, club-formed, three-cornered, with a long process directed towards the periphery. Nerve fibres collected into bundles pass from the medullary substance into this layer, some of which pass through it into the fourth and third layers. Arndt regards anastomosis between ganglion cells as a rare and accidental occurrence, and he has only once seen it. He then describes the arrangement of the blood-vessels, and points out that whilst some traverse the grey matter without giving off any branches until they enter the white matter, others form a rich network in the deep part of the grey matter, whilst in its superficial layers capillaries derived directly from the vessels of the pia mater are distributed. ——An abstract of a memoir ON THE WEIGHT OF THE BRAIN in the different races of men, by Dr J. Barnard Davis, appears in *Proc. R. S. Lond.* Jan. 23, 1868. His observations were made by gauging the internal capacity of crania with dry Calais sand of a definite specific weight, which was afterwards weighed and reduced to its equivalent in cerebral matter of 1040 sp. gr., 15 per cent. being deducted as an allowance for skull space not filled up by brain substance. The general conclusions are as follows: mean of European series 46·87 oz.: mean of Asiatic series 44·62 oz.: mean of African series rather more than $2\frac{1}{4}$ oz. less than European mean: mean of American series 44·73 oz.: mean of Australian series 41·38 oz.: of Tasmanian 42·25 oz.: mean of Malay skulls 47·07 oz.

BLOOD-VESSELS.—Bochdalek, Junr. (*Virchow's Archiv*, Nov. 1867, p. 259) describes a case of RIGHT AORTA, in which from the convexity of its arch, the left common carotid, the right common carotid, and the right subclavian arose; whilst the left subclavian sprang from the left aspect of the aorta, where the arch and descending thoracic aorta became continuous, and passed behind the œsophagus to the left side of the root of the neck. Half an inch from the origin of the left subclavian the obliterated ductus arteriosus joined it. This case obviously corresponds to the one described by W. Turner (*Brit. and For. Med. Chi. Rev.*, July and Oct. 1862), and though Bochdalek gives no explanation of its mode of formation, is clearly due to an atrophy of the 4th left vascular arch, and a persistence of both aortic roots and the 4th right vascular arch; the portion of the left subclavian behind the œsophagus being the persistent left aortic root.——Bochdalek, in the same *Archiv*, p. 260, records a case of variation of the CORONARY ARTERIES OF THE HEART, where the left was absent and the right supplied the substance of the organ: and on p. 261 another case, in which the RIGHT SUBCLAVIAN ARTERY passed, along with its vein, IN FRONT OF the lower end of the scalenus anticus.——Wenzel Gruber describes two cases (*Reichert and Du Bois Reymond's Archiv*, Pt. v. 1867) in which a SUPERNUMERARY DEEP CIRCUMFLEX ILII ARTERY arose from the external iliac some distance above Poupart's ligament; and in the 6th part of the same *Archiv*, a case of DUPLICITY of the ULNAR ARTERY, also one in which the ulnar-artery was superficial on the front of the fore-arm, and two cases in which there was a SUPERFICIAL MEDIAN ARTERY.——Charles Legros contributes a memoir ON THE ANATOMY AND PHYSIOLOGY OF THE ERECTILE TISSUE in the genital organs of birds and mammals (*Robin's Journal*, 1868, p. 1). He limits the term erectile tissue to the dilatations which immediately succeed the small arteries, and which he regards therefore as replacing and representing, in a more or less modified form, ordinary capillaries.——Dr Stricker (*Robin's Jl.*, 1867, p. 652) describes the STRUCTURE AND ORIGIN OF CAPILLARIES. He confirms the existence of perivascular spaces around the capillaries, as His and Robin had previously described in the brain, and Lightbody in the cornea, in this Journal, Nov. 1866. He concludes that the capillary walls are formed of protoplasm.——E. Sertoli (*Virchow's Archiv*, Feb. 1868, p. 370) does not agree with the conclusions of Banks and Arnold (see *Journ. Anat. and Phys.* Nov. 1867, p. 175) as to the COCCYGEAL BODY being an appendage of the arterial system. He regards it as a specific organ. The hollow spaces it contains are not dilated blood-vessels, but spaces possessing a fibrous envelope, into which a blood-vessel extends and ramifies amongst the cell structure contained in the spaces, which cells lie therefore outside the vessel. Provisionally, the body may be classed with the blood vascular glands, or even with 'nerve-glands.'

BLOOD CORPUSCLES.—El. Metschnikow concludes (in *Virchow's Archiv*, Jan. 1868, p. 523) from his observations on the DEVELOPMENT

OF THE RED-BLOOD CORPUSCLES in the chick, that the so-named nucleus is not to be regarded as homologous with the nucleus of a cell, but as an enlarged and persistent nucleolus, for whilst in their early stage of formation the blood corpuscules present both a nucleus and nucleolus, as they attain their perfect form, the latter enlarges and fills up the place of the nucleus, the outline of which entirely disappears. ——In the same *Archiv*, p. 395, Prof. Friedreich records some observations on MODIFICATIONS IN THE SIZE AND FORM of the human red-blood corpuscles, which he considers to be due to the contractile property of their protoplasm.

BLOOD VASCULAR GLANDS.—Dr Grandry communicates a long memoir on the STRUCTURE OF THE SUPRA-RENAL CAPSULE, PITUITARY AND PINEAL GLANDS (*Robin's Jl.*, 1867, pp. 225, 389). He considers the central cavity of the capsule as a cadaveric alteration, and regards the pituitary and pineal bodies as essentially similar in structure to the supra-renal capsule.——Dr Bochdalek, Junr., describes the arrangement of the PERITONEAL INVESTMENT OF THE SPLEEN (*Reichert and Bu Bois Reymond's Archiv*, 1867, Pt. v. p. 565). His description embraces many observations on the development of the peritoneal membrane.——Prof. V. Luschka describes (*Schultze's Archiv*, IV. 1868) ADENOID TISSUE in connection with the posterior and upper wall of the human pharynx. Between the mouths of the Eustachian tubes the surface of the mucous membrane is thrown into irregular folds, and in the middle line an opening, termed by F. Mayer, 'bursa pharyngea' exists. This irregularity is due to the occurrence in the mucous membrane of collections of cells, like lymph-corpuscles, which His has named adenoid tissue, and Henle has described as conglobate gland substance.

LIVER.—C. J. Eberth contributes observations on the LIVER IN THE VERTEBRATA (*Schultze's Archiv*, III. Pt. IV. 1867, p. 423). He recognizes amœboid movements in the fresh cortical cells of the liver of the salamander. He describes the pigment of the liver, and its variation more especially, in the amphibia. He studies the arrangement of the 'bile capillaries,' and speaks of the intralobular channels for the bile as sometimes surrounded immediately by the cells, at others by an intermediate substance connecting the cells together. His observations in the main agree with those of Hering recorded in the last number of this Journal.

KIDNEY.—Dr F. T. Roberts describes a case of HORSE-SHOE KIDNEY (*Liverpool Med. and Surg. Rep.* Oct. 1867, p. 60) in which the union of the cortical substance of the two glands in front of the aorta just above its bifurcation was complete. The ureters instead of passing behind the glands came forward, and then curved downwards over the upper concave border of the united kidneys on their way to the pelvis.——D. Rindowsky, a pupil of Chrzonszczewsky, records his observations on the TUBULI URINIFERI (*Virchow's Archiv*, Nov. 1867, p. 278). These tubes either end blind or in capsules. Capsules are

seated on convoluted tubules, which possess a granular epithelium, and these tubes are continuous with others which have a clear epithelium. Some capsules also communicate with straight tubes, which assume some distance from the capsule the convoluted character. The convoluted tubes and their capsules are in connection with straight tubes. The tubes with clear epithelium connect the convoluted and straight tubes, and they constitute the looped tubes which are found in the upper half of the medullary substance. Those tubes with clear epithelium, which Henle figures as processes of the convoluted tubes, are blood-vessels.

EYE.—Max Schultze (*Archiv*, III. 1867, p. 371) continues his observations on the STRUCTURE AND DEVELOPMENT OF THE RETINA. In mammalia born blind, as cats and rabbits, the bacillary layer is completely absent, but its formation begins soon after birth on the surface of the memb. limitans externa. The first appearance of the rods is about the 4th day, and from the 5th to the 6th indications of the outer segments appear in some of the rods, which become more distinct about the period when the eye-lids open, after which they increase both in length and thickness. The outer segments are apparently derived from a gradual prolongation of the inner segments. His observations on the development of the cones are made on the chick. They are very small before it leaves the egg, but increase in size immediately afterwards.——W. Krause (*Göttingen Nachrichten*, 12 March, 1868) speaks of a MEMBRANA FENESTRATA between the inner and outer granular layers of the retina formed of large, multipolar flat cells, which he regards as of the nature of connective tissue. It occurs in mammalia, birds and amphibia; and in fish it has long been known. He recognises three elements in the retina; a nervous, formed of the nerve-fibres, ganglion cells and the inner granular layer; a connective tissue, formed of the radial fibres, the external and internal limiting and the fenestrated membrane; and a katoptric-dioptric apparatus, consisting of the rods and cones with their ellipsoids and granules, and the choroidal pigment and tapetum. He thinks that the perception of light is limited to that which is reflected from the choroid, a conclusion which we may state was arrived at many years ago by John Goodsir (*Proc. R. S. Ed.* April 6, 1857, and *Collected Memoirs*, II. 273).——Fr. Merkel (*Henle and Pfeufer's Zeitschrift*, XXXI. 136, 1868) recognises in the IRIS two systems of muscular fibres, a radiated or dilatator pupillæ and a concentric or sphincter pupillæ.——F. E. Schulze (*Archiv*, III. p. 477) describes the MUSCULUS CILIARIS in the human eye-ball. His researches were conducted with the use of the chloride of palladium. He has seen smooth muscular fibres only on the anterior and outer surface of the corpus ciliare. With Henle and others he regards the fibrous element of the zonule of Zinn as elastic fibres. The anterior and outer part of the muscle is compact, whilst the inner is subdivided by connective tissue into a large-meshed network. The fibres of the compact part of the muscle run parallel to each other from before

backwards and outwards. In meridional sections the nuclei of this layer are seen in longitudinal sections, whilst the nuclei of the inner layer of fibres are transversely divided. The theory adopted by Schulze of the mode of action of this muscle in the accommodation of the eye is essentially the same as that of Helmholtz.——C. F. Müller concludes, from his researches into the STRUCTURE OF THE CORNEA (*Virchow's Archiv*, Vol. XLI. p. 110), that the corpuscles of the cornea are masses of protoplasm with enclosed nuclei, but without any special limiting membrane. The corneal tubes also are artificial, produced by injecting the cornea, and possess no limiting membrane.——T. Mauchle (*ibid.*, p. 148) enquires into the mode of termination of the NERVES IN THE OCULAR CONJUNCTIVA. He recognises the 'terminal bodies' of Krause, both in man and the calf, but has never been able to detect them in the rabbit, mouse and rat. A fine nervous plexus of pale fibres exists also in this membrane, which is independent of the terminal bodies.

EAR.—In the *Monatsschrift fur Ohren Heilkunde*, Oct. 1867, Dr Rüdinger describes the ANATOMY OF THE EUSTACHIAN TUBE in man and mammalia, and to the 2nd part of the same journal he communicates his researches into the MEMBRANOUS LABYRINTH. He regards the membranous labyrinth in the semicircular canals as excentric in position, and he distinguishes as independent structures a canalis semicircularis membranaceus minor, from a c. s. m. major. The major is in intimate connection with the periosteal covering of the osseous canal. In the small membranous canal the part of the wall which lies next the bone is lined by a polygonal epithelium, whilst that which is removed from the bone has large and small villi projecting from it into the canal.

OVUM.—In *Phil. Tr.* Pt. II. 1867, is printed in *extenso* the elaborate memoir of Dr W. H. Ransom, ON THE OVUM OF OSSEOUS FISHES, communicated to the R. S. June 21, 1866. He regards this ovum as a cell, a structural unit, the prototype of those units, which, variously aggregated and modified, form the mass of the higher organisms. The yelk-ball, like cell contents, is alone capable of undergoing multiplication. The yelk-sac again seems to grow interstitially and not by accretion upon either surface, or gradual transformation of the surface of the yelk-ball. The inner sac is the homologue of the primordial utricle, and its thicker portion with the granules of the discus proligerus would correspond to the granular mass around the nucleus in the plant cell. The food-yelk is equivalent to the fluid cell contents, and the germinal vesicle and spots hold the position of nucleus and nucleoli. He recognises two kinds of contractility in the cell contents or protoplasm, a rhythmic and a fissile; the former is not in any way influenced by the spermatozoids; the latter is independent of the action of the male element, but so far influenced by fecundation as to owe persistence and regular progress to it. The results of the fissile contractility are growth and development.

MALFORMATIONS.—In the *Liverpool Med. and Surg. Rep.*, Oct. 1867, Dr Rawdon describes a case of TRUE LATERAL HERMAPHRODITISM, in which a tolerably developed vagina and uterus were present. In the left broad ligament a Fallopian tube, a round ligament, and apparently a par-ovarium were found, but no trace of either testicle or ovary: in the right broad ligament a Fallopian tube and a distinct testicle, with an epididymis, and a vas deferens, which was traceable on the side of the uterus as far as the cervix, the junction between the testicle and epididymis being very feebly, if at all developed. The conformation of the pelvic cavity was between the male and female types. It was alleged by the person that a partial occurrence of the menstrual secretion took place regularly. The case is of interest in its bearings on the development of the genital apparatus, and, from the co-existence of a Fallopian tube and a vas deferens on the same side of the body, it supports the view that these ducts are developed from distinct embryonic structures, viz. from the Müllerian duct and the excretory duct of the Wolffian body.——A case of EPISPADIAS is recorded by Dr H. E. Eastlake (*Med. Times and Gaz.*, July 20, 1867) in a male infant in which there was no extroversion of the bladder; the pubic bones were united, and the infant could retain its water.——A case of PARTIAL EPISPADIAS is also described and figured by A. Pribram (*Prag. Vierteljahrscrift*, IV. 44, 1867), which closely resembles one previously recorded by Luschka in *Virchow's Archiv*, Dec. 1865. In this case the glans was fissured on its dorsal surface in and immediately in front of the corona, but this fissure did not extend into the urethra. At the root of the dorsal surface of the penis was a funnel-shaped opening, communicating with a fine canal lined with a mucous membrane, which ran backwards towards the junction of the crura penis, and seemed to end in a cul-de-sac. This canal had no communication so far as could be detected with the urethra.——Two cases of EPISPADIAS are also recorded by Rudolf Bergh, of Copenhagen, in *Virchow's Archiv*, XLI. 305, who remarks that in Danish literature no case up to the publication of these two had been recorded. He gives a historical account of the malformation, and states that, of the 27 cases up to this time recorded, 24 were complete, and that his examples belong to the same category. The first occurred in a strong muscular man with a large penis and glans; the symphysis pubis was normal, the bladder was small and not extroverted. The under surface of the penis flat, the upper deeply fissured in its whole length, and the furrow passed back under the symphysis. The two corpora cavernosa were completely separate from each other, and the fissured urethra had in relation to its sides and floor a cavernous structure. The second case occurred in a boy of 15, and was a very characteristic example.——In the *Brit. Med. Jl.*, March 21, 1868, Mr T. Smith describes a case of ECTOPIA VESICÆ in a female æt. 4½. The bladder was covered with a structure resembling skin as low as the openings of the ureters: the pubes was cleft and the abdomen deficient in the middle line from the navel downwards. The vagina

and uterus were present: the labia fully and the nymphæ slightly developed.——Julius Jensen records (*Virchow's Archiv*, Feb. 1868, p. 236) an example of CONGENITAL ABDOMINAL HERNIA, in which the liver, stomach, spleen, and the greatest part of the intestine were situated in a membranous sac projecting from the anterior wall of the abdomen. The lower limbs also were imperfectly developed, and bands of adhesion passed from the sac to the body and limbs of the fœtus.

COMPARATIVE ANATOMY AND MORPHOLOGY.

Wenzel Gruber records (*Reichert and Du Bois Reymond's Archiv*, Oct. 1867, p. 542) the presence of a CERVICAL RIB in a dog. It occurred on the left side in connection with the transverse process of the 7th cervical vertebra, with which it articulated by one extremity, whilst by the other it was attached by a strong articular capsule to a process projecting from the 1st thoracic rib.——M. S. Arloing contributes a memoir ON THE ORGANIZATION OF THE HORSE'S FOOT (*Ann. des Sc. Nat.* VIII. 55), in which he specially describes a specimen of supernumerary digit, and one of cloven hoof met with in adult animals. In the latter specimen the 3rd and 2nd phalanges were each completely divided into two, whilst the 1st phalanx in its two inferior thirds was separated into two divergent portions, and closely approached the form of the 1st phalanx in the ox. Two large sesamoid bones were found behind the upper end of the 1st phalanx and two small bones behind the 3rd. He considers that this case indicates the true duplicity of the digit in the soliped.——Dr Fischer notes in the comp. anatomy collection of the Natural History Museum in Paris THE LOWER JAW OF A CACHALOT (*Robin's Jl.*, 1867, p. 382) which, like those previously described by Dr Murie (*Proc. Zool. Soc.* Lond. 1865), presented a remarkable twist at its anterior end. In Fischer's case the torsion was to the right.——Prof. Huxley calls in question (*Proc. R. S. Lond.* Jan. 30, 1868) various of the conclusions previously arrived at by Professor Owen respecting the bones of ARCHÆOPTERYX LITHOGRAPHICA. He considers that the fossil presents in general its dorsal and not its ventral aspect to the eye, though one of the bones, the furculum, may have been twisted round so as to exhibit its ventral face; and thus the bones previously described as right femur, tibia, and bones of the right foot, are really bones of the left hinder limb. Similarly, the interpretation given to the scapulæ, humeri, innominate bones, &c., is disputed.

Prof. van der Hoeven[1] (*Act. Acad. Cæs. Leop. Car.* XXXIII.) describes the anatomy of the SKELETON OF DROMAS ARDEOLA. He defines the genus as follows:—rostrum rectum, validum, elongatum, inerme, mandibula inferiori gibbosa. The specific characters are:—

[1] It is with unfeigned regret that we note the death of this indefatigable and eminent Zoologist.

alba, occipite rectricibusque supra canescentibus, dorso remigibusque majoribus extrorsum nigris.——St George Mivart contributes to the *Trans. Zool. S.* VI. 1867, an elaborate memoir on the APPENDICULAR SKELETON OF SIMIA, in which he compares its limb-bones with those of the Chimpanzee, Gorilla and Man.——And the same anatomist communicates to the *Phil. Trans.* 1866–67, an exhaustive memoir On the SKELETON OF THE LIMBS OF THE PRIMATES. He sums up the results of his observations as follows:—The Primates present in their appendicular skeleton six principal types of structure; (1) Homo; (2) Simia; (3) Cercopithecus; (4) Nycticebus; (5) Lemur; (6) Tarsius. The first has, however, relations both with the third and fourth, some of the Nycticebinæ resembling man more than all, or almost all the other Primates in the proportion borne by the arm, without the manus, to the spine: in the proportion borne by the radius and ulna to the same: in the length of the pollex as compared with that of the longest digit: in the proportion borne by the tibia to the humerus and to the femur: in the length of the pes as compared with that of the tibia: in the marked anterior vertebral angle of the scapula: in the small supraspinous fossa: in the excess of the infraspinous over the supraspinous fossa near the glenoid surface: in the short symphysis pubis: in the very peculiar ischial tuber. Moreover, one or more of the Nycticebinæ differ from the other Lemuroidea and approximate to man in the degree of sigmoid curve of the clavicle, and in the absence in one genus of the supra-condyloid foramen in the humerus. A tree may fairly symbolise the affinities of the groups as represented by their appendicular skeleton. Its trunk divides into an Anthropoid and a Lemuroid branch. From the former a secondary branch, which represents man, arises, and then two other secondary branches for the American apes. It then bifurcates to symbolise the Simiinæ and lower Simiidæ. The secondary branch for the Cebidæ gives off a very distinct twig to represent Ateles, and Lagothrix and Mycetes are also special forms. The secondary branch, standing for the lower Simiidæ, gives off a twig for the Semnopithecinæ, which is parallel to that for Ateles. That for the Simiinæ gives off twigs (for Troglodytes) which approximate in direction to that followed by the branch representing man. It then gives off another twig for Hylobates, and culminates in Simia. The second main branch gives off, almost from its starting point, and on the side next the higher Primates, a secondary branch to represent the Nycticebinæ. Higher up on the same side another twig stands for Indrisinæ, whilst the branch culminates in Lemur. On its outer side the branch gives off twigs for Galago and Cheiromys, whilst almost from the base and widely diverging a twig arises which symbolises the very anomalous genus Tarsius.

Dr Günther communicates to *Phil. Trans.* XXIII. Pt. II. 1867, an important memoir on the ANATOMY OF HATTERIA (Rhynchocephalus, Owen), a remarkable saurian from New Zealand. Its structural characters lead him to rank it as a member of a third order of the

Squamata, which he calls Rhynchocephalia, and defines as follows: quadrate bone suturally and immoveably united with the skull and pterygoid: columella present: parts of the ali and orbito-sphenoid regions fibro-cartilaginous: rami of the mandible united by a short fibrous ligament: temporal region with two horizontal bars. Vertebræ amphicælian: copulatory organs none.——St George Mivart describes (*Proc. Zool. S.* March 14, 1867) the skull of Indris Diadema.——In *Jenaische Zeitschrift*, III. 359, Prof. Gegenbaur communicates an important and well illustrated memoir, in which he considers the Development of the Vertebral Column in Lepidosteus: compares the sheath of the chorda dorsalis in the ganoids with the same structure in the other vertebrata: gives a comparative view of the structure of the vertebral column, and discusses the nature of the vertebral arches.——M. A. Goubaux points out at great length in *Robin's Jl.*, 1867, p. 602, and 1868, p. 53, that variations in the Spinal Column may occur in every species of domestic animal, but that they are to be regarded as belonging to the individual, and not as family or race characters.——Jeffries Wyman discusses in *Proc. Boston Nat. Hist. S.*, June 5, 1867, Symmetry and Homology in Limbs. After some general observations on the subject, in which he adopts the view that the fore and hind limbs are symmetrical parts, repeating each other in a reversed manner from before backwards, as right and left parts do from side to side, he considers the nature of the scapular and pelvic arches, and following the principles of what he terms symmetrical development, he considers the scapula and ilium, clavicle and ischium, coracoid and pubes, to be homologous bones. With respect to the limbs he regards them as at first outgrowths of the tegumentary cells, without bones or other tissues, which are subsequently developed *in* the limbs and then grow *pari passu* with them. They do not appear to be dependencies of the scapular and pelvic arches, but belong to the category of tegumentary organs, and their connection with the vertebral column through those arches is only secondary, as is that of the teeth with the jaws. He regards the humerus and femur as symmetrical repetitions, and makes the radius homologous with the fibula, the ulna with the tibia, and agrees with Sömmering, Owen, &c. that the patella is a sesamoid bone. The tarsal and carpal bones are related as follows: trapezium, cuboid; trapezoid, cuneiform; magnum, 2nd cuneiform; unciform, 1st cuneiform; scaphoid, astragalus; lunare, os calcis; pyramidale, scaphoid; whilst the pisiform is probably only a sesamoid bone and has no representative in the foot. The metacarpals are homologous with the metatarsals, but it is probable that the thumb with its two phalanges is the homotype of the outer toe with its three phalanges.——Dr Burt G. Wilder (*Silliman's Jl.*, July, 1867, p. 44) discusses the Morphological Value and Relations of the Human Hand. He considers that polarity is a primary law in the formation, structure, and general function of the vertebrate body. The anterior and posterior regions of the body are the two poles of a longitudinal axis, and their constituent parts repeat each other in opposite directions, like the

corresponding organs on the right and left sides. In comparing the fore and hind limb he supinates the hand, places it with the palm downwards and the fingers *pointing backwards*, and with the wrist in front, just as the toes point forward and the heel is behind. In this position the ulna is wholly on the inner side of the fore arm and corresponds to the tibia, whilst the radius corresponds to the fibula; the thumb is on the outer side of the hand and corresponds to the little toe, whilst the little finger and great toe are homologous.

St George Mivart communicates to the *Proc. Zool. S. L.* June 27, 1867, important details respecting the MYOLOGY OF IGUANA TUBERCULATA, but the paper is not one of which an abstract can be conveniently made.——The Rev. S. Haughton, M.D. gives an account (*Annals of Nat. Hist.* April, 1868) OF THE MUSCULAR ANATOMY OF THE ALLIGATOR, in which he reiterates most of his views respecting various of the bones and muscles called in question by Dr Hair in our last number, but admits his error in confounding the glutæus minimus with the tensor fasciæ femoris. He represents the bones of its pelvic arch as ischium, ilium, marsupiale and pubes. He gives the weight of the different muscles, and agrees with Vicq. d'Azyr, that the left leg should be compared with the right arm, and concludes that the analogous muscles of the hip and shoulder of the same side are arranged in reverse order. The marsupial muscles do not correspond with the obturators, but find their analogues in a muscle whose direction lies between the latissimus dorsi and pectorals. The analogue of the obturators is found in the second pectoral of birds, which acts as a levator humeri, and whose line of direction is between the pectorals. This muscle may possibly be represented in the crocodile and alligator by the pectoral muscle extended from the 1st sternal rib to the posterior edge of the coracoid.——Alex. Macalister (*Proc. Zool. S. L.* May 9, 1867) makes observations on the following points in the ANATOMY OF GLOBIO-CEPHALUS SVINEVAL. 1st, the anatomy of the pharynx and larynx; 2nd, the spinal muscles; 3rd, the structures forming the superior extremity. His paper treats of parts which were not described by the Reporter in his contribution to the anatomy of Globio-cephalus printed in our last number.——Wharton Jones in *Proc. R. S. L.* Jan. 9, 1868, argues that the CAUDAL HEART OF THE EEL is a lymphatic heart, its function being to receive lymph on the one hand and to propel it into the great vein of the tail on the other, but that besides this function, it at the same time performs the secondary one of accelerating and promoting the flow of the blood in the great caudal vein in its course back to the blood-heart.——Prof. Kölliker (*Verhand. phys. med. gesells. in Würzburg*, 28 Dec. 1867) describes the STRUCTURE AND FORMATION OF THE POLYPARY OF TUBIPORA. In its upper part it is soft and flexible and formed of connective tissue with red spicules, the hard part of the tubes is produced by a blending of such spicules: colourless spicules occur also in the bodies and tentacles of the polyps of tubipora. He describes also a POLYMORPHISM in the individuals of the anthozoa

or the Alcyonian polyps, some of which possess both nutritive and reproductive organs, whilst others are without reproductive organs, and these latter possess no tentacles. Two types of arrangement of the polyps without reproductive organs are found: in the one they are seated over the entire polyp-bearing stem, between the reproductive polyps: in the other they are collected in particular localities, which vary with, but are definite in, each genus.——Dr T. Spencer Cobbold (*Linnean Soc. Jl.* IX. 200) offers remarks on DISTOMA CLAVATUM from the stomach of *Xiphias gladius*. He considers that this parasite may be viewed as representing a variety of forms hitherto regarded as separate species.——E. Ray Lankester (*Ann. Nat. Hist.* Nov. 1867) describes in the LIMPET (*Patella vulgata*) an orifice, which he terms capitopedal, on each side of the "head" in the angle formed by the muscular foot, and opening into the blood sinus surrounding the pharyngeal viscera: also a pair of very large, orange-coloured salivary glands opening by two ducts on each side into the buccal cavity. He gives a more complete account of the renal organ and of the laminated crop, and confirms the statement of Robin and Lebert as to the absence of ovi or sperm-duct.

REPORT ON THE PROGRESS OF PHYSIOLOGY from 1st August 1867, to 1st March 1868. By THOMAS R. FRASER, M.D., WILLIAM RUTHERFORD, M.D. and ARTHUR GAMGEE, M.D. *Edinburgh*[1].

DR RUTHERFORD'S REPORT.

Circulation.

HEART.—Friedländer (*Bezold's Untersuchungen*, 1867, p. 165, *Centralblatt*, No. 26, 1867), gives the following results of investigations into the physiology of the frog's heart. Some portions of the frog's heart continue to contract rhythmically for a period varying from two to seventy minutes, sometimes even for forty-eight hours. The portions of the heart were placed in an artificial serum consisting of 1 part of egg-albumen to 9 parts of a 0·8—0·9 per cent. solution of chloride of sodium. He could never obtain a portion of the heart, however small, which if it contracted rhythmically was not found to contain ganglia. Gentle pressure or a current in the fluid rendered the contraction more frequent. When the temperature was slowly or suddenly raised to 25° or 35° Centigrade, the contractions were greatly increased in rapidity, often to two or three in a second. At 40° C. the contractions became irregular and afterwards tetanic. Weak interrupted electrical currents frequently increased the strength and not the frequency of the contractions; sometimes the contractions were slowed, at other times quickened. Strong currents produced tetanus.

Prompt (*Archives de Physiologie*, 1868, p. 258) draws attention to the absence of *exactness* in the observations regarding the time during which the frog's heart will continue to contract after its excision. He considers that the estimates hitherto given cannot be relied upon because sufficient attention has not been paid to the fact that *spontaneous* may very easily be converted into *excited* movements. He shows that the mere contact of the breath of the observer is sufficient to render such observations fallacious. Having carefully attempted to guard against all external causes of excitation, he found that the spontaneous contractions usually continued in summer for one hour or for one hour and a half, and in winter for three or four hours. Valentin said that they usually continue for twenty-four hours.

HEART AND VAGUS.—Onimus ("On the influence of constant and interrupted electric currents on involuntary Muscular Fibre and

[1] The Report on the Action of Medicinal and Poisonous Substance is written by Dr Fraser; that on Physiological Chemistry by Dr Gamgee, and the remainder by Dr Rutherford. In order to assist in making these Reports more complete, the Authors will be glad to receive copies of original memoirs and other contributions to Physiology.

on Nutrition," *Comptes Rendus*, 1867, p. 250, and *Jl. de l'Anatomie*, 1868, p. 94), among other interesting facts, gives the following regarding the influence of electrical currents on the vagi, heart and blood-vessels. A weak continuous galvanic current when passed through the heart quickens the rate of its contractions. During the passage of a strong ascending continuous current through the inferior portion of the vagus divided in the neck, there was no change in the circulation or respiration. A descending current increased the rapidity of the heart's action. An ascending current passed through the upper extremity of the divided vagus slowed and often completely arrested the respiration. The cardiac movements became, in consequence of this, less frequent and energetic. A descending current produced hardly any effect. It was necessary to make the descending current twice or three times as strong as the ascending ere it produced the same result. It thus appears that the action of continuous currents upon the cephalic portion of the divided vagus approaches that of interrupted currents. He also finds that a continuous current when applied directly to the arteries of warm-blooded animals produced no notable change. When applied to the vena cava of a rabbit it produced marked contraction.

Influence of Vagus on Arterial Blood-Pressure.—Dr Dreschfeld (*Bezold's Untersuchungen*, 1867, p. 326) remarks with regard to the lowering of the blood-tension produced by irritating the upper end of the divided superior cardiac branch of the vagus in rabbits (See *Jl. of Anatomy and Physiology*, No. I. p. 190, 1867), that Von Bezold had in 1863 observed the fact that the blood-pressure is lowered on irritating the cephalic end of the divided vagus after removal of the cerebrum. Von Bezold thought this was due to an inhibitory action upon the motor cardiac centres of the medulla oblongata. The doubt remained whether in so doing Von Bezold had irritated merely the trunk of the vagus or had included its superior cardiac branch. To remove this Dreschfeld performed many interesting experiments on rabbits; and he found, that if the cerebrum be removed, or if it be paralysed by morphia, irritation of the cranial extremity of the divided vagus lowers the pressure of the blood to a greater extent than similar irritation of the superior cardiac nerve. But when the cerebrum was intact, irritation of the superior cardiac nerve lowered the blood-tension just as in the former case, while irritation of the vagus on the other hand caused an increase. Dreschfeld thinks that this increase of blood-pressure may be due to the calling forth of psychical influences, or to the irritation of vasomotor fibres which pass through the brain. The lowering of the blood-pressure is due, as Cyon and Ludwig correctly pointed out, to dilatation of blood-vessels. Friedländer and he (*Ibid.* p. 333) found that the blood-tension was always lowered on directly irritating the heart; this resulted whether the vagi and sympathetics were divided or not. The frequency of the pulse was usually increased, only however when the irritating current was

weak. The blood-pressure was in most instances lowered when the stomach was irritated. Irritation of the lungs produced no effect.

Irritability of Cardiac Terminations of Vagus. — Dr Suschtschinsky of Moscow (*Centralblatt*, 1868, p. 34), in a preliminary communication gives the following results of his experiments "On the influence of increased and diminished blood-pressure and altered Cardiac Nutrition on the irritability of the Cardiac terminations of the Vagus."

1. Section of both cervical sympathetics produces no change on the irritability of the cardiac terminations of the vagus.
2. Complete removal of the influence of the cardiac motor nerves increases the irritability.
3. During decided increase of blood-pressure in the left side of the heart, through closure by forceps of the ascending portion of the aorta, irritation of the vagus can no longer stop the heart's action; if however the coronary arteries be closed, irritation of the vagus can arrest the heart.
4. Increase of blood-tension in the right side of the heart by clamping the pulmonary artery likewise annihilates for the time being the irritability of the vagus terminations.
5. Diminished arterial tension, whether produced by bleeding or paralysis of vasomotor nerves, produces at first increased, afterwards diminished irritability.
6. Insufficient supply of arterial blood to the muscular substance of the heart in consequence of closure of the coronary arteries increases the irritability, not however to such a remarkable degree as venous stagnation produced by closure of the three chief cardiac veins.
7. Insufficiently aerated blood greatly increases the irritability of the vagus, as Thiry, Cyon and others have already shown. Hyperoxygenation of the blood often slightly diminishes the irritability of the vagus, but frequently also produces no change (Traube).

Influence of Intracardial Pressure on rapidity of Cardiac Action.—Von Bezold and Stezinsky (*Bezold's Untersuch.* 1867, p. 195), confirm the results obtained by M. and E. Cyon with regard to the influence of increased arterial tension on the frequency of the pulse. They found that when the arterial tension was increased to a certain point, the pulse was quickened, but when increased beyond that point, the pulse was slowed. Increased blood-tension in the right side of the heart produced no distinct alteration. When these experiments were performed, the vagi, cervical sympathetics, and cervical spinal cord were divided before observing the influence of altered pressure.

Influence of Loss of Blood upon the Frequency of the Pulse.—According to Von Bezold (*Bezold's Untersuch.* 1867, p. 215) loss of blood produces *pari passu* with lowered blood tension slowing of the pulse, provided the heart be entirely cut off from the central nervous system. If the spinal cord be intact while the vagi and

cervical sympathetics are divided the hæmorrhage greatly quickens the pulse.

INFLUENCE OF CLOSURE OF THE CORONARY VESSELS UPON CARDIAC ACTION.—Von Bezold (*Untersuch.* 1867, p. 256) found that when the coronary arteries of rabbits are closed with forceps—after previous division of the vagi, cervical sympathetics and cervical spinal cord—the heart continues to beat for ten or fifteen seconds unaltered. After this the heart's contractions usually become less frequent and irregular. Then the ventricular contractions become twice as slow as those of the auricles. After this they become vermicular, and usually in from one to one and a half minute after the closure of the arteries the ventricles are motionless while the auricles pulsate weakly. When he closed the aorta immediately after closing the coronary arteries and thereby increased the blood pressure in the heart, the heart's contractions were immediately thereafter quickened, soon, however, their frequency was diminished. The fact that increase of the intracardial pressure quickened the heart's action notwithstanding the closure of the coronary arteries, shows that quickening of cardiac action does not follow irritation of cardiac motor nerves in virtue of their being *vasomotor* nerves, as Traube has supposed. Venous hyperæmia produced by closing the coronary veins occasions, according to Von Bezold and Breymann (*Untersuch.* p. 288), first increase, then diminution of the heart's speed. If the coronary veins be closed and immediately afterwards the aorta, so that intracardial pressure may be increased, the pulse at first becomes more rapid.

INNERVATION OF THE HEART FROM THE SPINAL CORD.—Dr M. and E. Cyon (Reichert's *Archiv*, 1867, p. 389) give a historical sketch of this subject, in which they award credit to Le Gallois and Wilson Philip for having been the first who endeavoured to throw light on the question by experiment. In their opinion our knowledge of the matter was not advanced by Von Bezold in his Memoir on the Innervation of the Heart (Part II). Von Bezold divided the spinal cord at the atlas, and found as the result a slower rate of cardiac action and diminution of the arterial blood-pressure; on the other hand, he irritated the cervical portion of the spinal cord and found that the heart's movements were accelerated and the blood-pressure increased. He thought that the former facts showed that influences are continually passing from the brain to accelerate cardiac movement; and he further thought that the changes in the blood-pressure, which followed the section and the irritation, were due to changes in the cardiac action. Ludwig and Cyon found that his results are quite correct, but his explanations of them entirely erroneous. In their opinion the slowing of the heart, which follows section of the cord at the atlas, may be due to the lowering of the blood-pressure, owing to the division of vasomotor nerves whose centre is in the brain. Again, the quickened action of the heart, due to irritation of the cervical portion of the spinal

cord, is the result not only of the direct irritation of cardiomotor nerve-fibres but of the increased blood-pressure due to irritation of vasomotor nerves. That increase of the blood-pressure is alone able to quicken the heart's action they showed, by dividing all the cardiac nerves by a galvano-caustic wire and then irritating the lower portion of the divided spinal cord, as the result of which they found that the heart's action was quickened. The brothers Cyon repeated these experiments and entirely confirmed Ludwig and Cyon's results. As it was therefore clear that it had not yet been proved that irritation of the spinal cord is able to directly quicken the heart apart from its secondary action on the heart's movements through the altered blood-pressure, these gentlemen performed a number of experiments destined to settle this question. They divided the splanchnic nerves, the cervical sympathetics, vagi, and spinal cord at atlas, and found that on irritating the cord the heart's action was quickened, but the blood-pressure remained unaltered. (They had divided nearly all the vasomotor nerves of the body.)

This experiment brings out the interesting fact that the heart's action may be accelerated without producing any increase of the arterial tension; that is, without any increase of the work performed by the heart. And a series of similar experiments showed for the first time that irritation of the spinal cord can increase the frequency of the heart's contractions independently of change in the blood-pressure. They moreover found that all the nerves—which convey the influences of stimuli from the spinal cord to the heart when the former is irritated—pass through the last cervical and first dorsal ganglia. Irritation of the cord produced no effect on the heart when the splanchnics, cervical sympathetics, and vagi were divided, and these ganglia removed on both sides. They further found that direct irritation of the third branch of the inferior cervical ganglion (counting from within outwards) in rabbits, and of the first branch in the dog, quickens the heart's movements without influencing the blood-pressure. They have therefore proved, by direct experiment, that there are nerves connecting the heart with the brain, which when irritated directly influence the heart so as to quicken its action.

Movement of the Blood.—Lortet (*Researches on the Rapidity of the Blood-current in the Arteries of the Horse by means of a new Hæmodromograph*, 4to. pp. 40, Paris, 1867) has constructed an apparatus for measuring the rapidity of the blood-current somewhat similar to the tachometer. After comparing the pressure with the rapidity of the blood in the arteries he gives the following results. At the cardiac systole strong pressure and great rapidity are simultaneously produced; the former attains its maximum later than the second. The maximum of pressure is maintained nearly until the ventricle begins to dilate; the rapidity begins to fall before the pressure. When however the pressure does begin to fall it sinks much more quickly than the rapidity. At the moment of closure of the sigmoid valves there is a rapid rise of pressure in the arteries which passes along

the vessels in the form of a wave, while simultaneously the rapidity falls remarkably owing to arrestment of the current in the commencement of the aorta. In the carotid during mastication the pressure falls while the rapidity of the current and the frequency of the pulse increase. After division of the spinal cord immediately above the atlas there is a great momentary increase of rapidity of the current at the systole, which however falls very quickly. Section of both vagi increases the frequency of the pulse, the pressure and the rapidity of the blood-current. When one carotid is ligatured the rapidity of the current is greatly increased in the other. According to Von Bezold and Gscheidlen ("On the Locomotion of the Blood by the Muscular fibres of the Vessels." *Bezold's Untersuch.* 1867, p. 347) the muscular fibres in the arterial walls contract peristaltically, and thereby assist in the movement of the blood towards the veins.

VASOMOTOR NERVES OF CEREBRAL VESSELS.—According to Nothnagel (*Virchow's Archiv*, XL. 203) some of the vasomotor nerves of the arteries of the pia mater have their origin within the cranium, others originate in the superior cervical ganglion, while a third set are contained in the trunk of the sympathetic in the neck. He finds that electrical irritation of cutaneous nerves, such as the sciatic or trigeminus, causes contraction of the vessels of the pia mater. Lovén found the reverse (*Centralblatt*, 1867, p. 56). Nothnagel supports Kussmaul and Tenner's supposition that epileptic convulsions are due to reflex contraction of the vessels in the brain in consequence of the irritation of peripheral sensory nerves.

Nervous System.

MEDIAN NERVE.—Richet (*Union Médicale*, No. 136, 1867) relates the case of a woman in whom one median nerve was accidentally divided above the wrist. Both ends of the divided nerve could be seen lying in the wound, and a portion four millimètres in length was removed from the peripheric end and examined with the microscope. Nevertheless the palmar skin supplied by the median retained its sensibility unimpaired. He therefore thinks that the influences of impressions produced on the terminal filaments of the median may be conveyed to the brain through its anastomosing branches with the ulnar and radial nerves. Révillout (*Gazette des Hopitaux*, 1866, No. 131) gives an account of a similar case.

INFLUENCE OF THE POSTERIOR ROOT OF A SPINAL NERVE UPON THE IRRITABILITY OF THE ANTERIOR.—E. Cyon in 1845 said that the anterior roots of spinal nerves have a certain degree of irritability

communicated to them by the posterior roots, that is, by the influences which may be transmitted through the latter. Von Bezold and Dr Uspensky (*Centralblatt*, p. 611, 1867) investigated the subject and denied this. Cyon replied (*Centralblatt*, p. 645, 1867) that his opponents had performed their experiments in a manner which rendered them worthless, inasmuch as they had experimented on frogs poisoned with woorara, and on sensory nerves deprived of their supply of blood. In reply to this, Von Bezold and Uspensky (*Centralblatt*, p. 819, 1867) gave the results of a series of experiments performed differently from their previous ones, but which entirely support their position. They laid the anterior roots of two spinal nerves of either side upon the electrodes and ascertained their degree of excitability. The posterior roots of the nerves were then divided on one side by means of sharp scissors, after which the irritability of the anterior roots was immediately tested on both sides and found to remain unchanged. The irritability afterwards sank on both sides with equal rapidity.

Digestive System.

VOMITING.—Schiff ("On the active part taken by the Stomach in the Mechanism of Vomiting," *Moleschott's Untersuch.* x. 353—405. *Centralblatt*, No. 37, 1867) from experiments on dogs concludes that during vomiting the muscular fibres of the stomach contract, the contraction taking place chiefly in the longitudinal fibres beginning at the pylorus. He finds also that during vomiting there is an active dilatation of the cardiac orifice. (These facts however seem to have been previously observed. See *Carpenter's Physiology*, Sixth Edition.)

The active dilatation of the cardiac orifice of the stomach appears to be effected through the spinal accessory; it does not occur after its division. Schiff alleges as the reason why horses and cows cannot vomit that the gastric extremity of the œsophagus instead of being opened is forcibly closed by the approximation of the stomach and diaphragm.

Glands.

PAROTID.—Eckhard (*Beiträge*, IV. Heft 2), in opposition to the strictures of Wittich (see *Journal of Anatomy and Physiology*, Vol. I. p. 361), maintains that the statements put forth by him regarding the parotid of the sheep are correct. (See *Journal of Anatomy and Physiology*, *l. c.*)

Vierheller (*Inaug. Diss.* Giessen) confirms Eckhard's conclusions by a number of experiments.

LACHRYMAL GLAND.—Dr Herzenstein of Odessa (*Reichert's Archiv*, p. 651, 1867) finds that irritation of the lachrymal nerves in sheep, dogs, and rabbits, increases the lachrymal secretion. The increase is trivial if a clamp be previously placed on the carotid. Irritation of the cervical sympathetic sometimes gives positive at

other times negative results. Division of the lachrymal nerve arrests the secretion; in a few days however it becomes re-established. Section of the sympathetic in the neck has apparently no influence. In dogs the lachrymal nerve of one side was divided. Ammonia was then held before the nostril of the same side, the other nostril being covered, no secretion of tears resulted: when however the ammonia was inhaled by the other nostril an abundant secretion flowed from the gland whose lachrymal nerve was intact. As has been observed by others, woorara produces a great increase in the lachrymal secretion. Herzenstein finds that this results even though the lachrymal nerve be previously divided; the increase is not however so marked as when that nerve is intact.

LIVER.—Lichtheim ("On the Influence of Irritation of the Spinal Cord on the Secretion of Bile," *Inaug. Diss.* p. 31. Berlin, 1867. Abstract in *Centralblatt*, p. 662, 1867) concludes, from his experiments on guinea-pigs, that irritation of the spinal cord by means of inducted currents diminishes the secretion of bile.

Special Sense.

TASTE.—Schiff (*Moleschott's Untersuch.* x. 406. *Centralblatt*, No. 38, 1867) in opposition to the opinion expressed by Lusana and Inzani, and recently by Neumann (*Centralblatt*, 1864, p. 632), that the chorda tympani is the only gustatory nerve for the anterior part of the tongue, adduces the following results of his experiments on animals in which both glossopharyngeal nerves had been previously extirpated: (1) After section of the lingual nerve immediately above its connection with the chorda tympani there was weakened but nevertheless distinct sense of taste, particularly good for acids, with complete paralysis of ordinary sensibility. The section was made in two cats close under the foramen ovale, taste remained almost unimpaired until the well-known injury from biting the insensible tongue was inflicted: (2) After section of all the nerves which communicate with the lingual, with preservation of the latter however, there was in three cases in which the operation succeeded complete absence of taste but unimpaired tactile and ordinary sensibility: (3) Section of the fifth nerve within the cranium, or of its second or fourth branches only, without previous division of the glossopharyngeal nerves, annihilated the sense of taste, as is already well known: (4) After section of the superior maxillary division of the fifth above the branches which go to Meckel's ganglion, or of these branches themselves, or of the branches which proceed from the posterior part of the ganglion to form the vidian nerve, or after destruction of the posterior part of the ganglion itself, there was complete loss of gustatory sensibility in the anterior part of the tongue, which however retained its ordinary sensibility. It thus appears that in the superior maxillary division of the fifth all the gustatory nerves for the anterior part of the tongue are to be found originally: they run for some

distance with the portio dura, and are added to the lingual partly through the chorda tympani, and partly, especially in dogs and cats, through other anastomoses.

VISION.—Czerny ("On Blinding of the Retina by Sunlight," *Wiener Acad. Sitzbericht*, 2 Abtheil. LVI. Abstract in *Centralblatt*, p. 856, 1867) found that the rays of light when concentrated by means of a lens upon the retina of a frog for 10 or 15 seconds produce a luminous spot, which in the course of a few hours becomes clearer, and at its circumference somewhat yellow. A similar result is produced in birds and mammals. The various elements of the retina in the spot disintegrate. In such a case too the fibres of the crystalline lens become molecular. The remarkable fact is that these effects are produced after the heating rays are absorbed before entering the eye; he refers them to action of the luminous rays.

Generation.

PENIS.—Eckhard (*Beiträge*, 1867, IV. 71) considers that dilatation of the vessels in the penis of the dog, produced by irritation of nerves, may be due to relaxation of the circular, or to contraction of the longitudinal muscular fibres of the arterial walls. The longitudinal fibres are very numerous, and are so connected to the small openings at the arterial dilatations, that their contraction would permit of an increased flow of blood into the latter. He found that during erection the blood tension in the femoral artery sank. In his opinion the corpus cavernosum possesses but a slight independent power of erection after removal of the corpus spongiosum.

PARTURITION.—Assuming that the strength of the amnion affords a good basis from which to estimate the expulsive force exerted during parturition, Dr J. Matthews Duncan (*Trans. R. S. Edin.* XXIV. Part iii. p. 639) made about a hundred experiments with a view to ascertain the strength of this membrane. He considers that the power required for the weakest labour is at least 4·08 pounds, for the strongest 37·58 pounds, and for average labour 16·73 pounds.

ORIGIN OF INFUSORIA.—Prof. Bennett, in a lecture "On the Atmospheric Germ Theory and Origin of Infusoria," delivered before the Royal College of Surgeons, Edinburgh, on January 17, 1868, (*Edinb. Med. J.*, March, 1868), stated the conclusions to which he had been led by observations conducted by him for a number of years. He considers that the infusoria, "vegetable and animal, which we find in organic fluids during fermentation and putrefaction, originate in oleo-albuminous molecules, which are formed in the fluids, and which, floating to the surface—constitute the primordial mucous layer of Burdach—the proligerous pellicle of Pouchet. There, under the influence of certain conditions, such as temperature, light, chemical exchanges, density, and composition of the atmospheric air, and of the fluid, &c., the molecules by their coalescence produce the

lower forms of vegetable and animal life." He carefully describes the movements of bacteria and vibriones: and the disputed question as to how these grow in length he has settled by actual observation. On two occasions he saw two isolated bacteria unite together lengthways, so as to form a single moving filament. He points out that the so-called germs, collected by Pasteur from the air by means of gun-cotton, are wholly unlike the great majority of the particles we see in the proligerous pellicle. Moreover, these so-called germs, when they can be detected are exceedingly few in number, whereas any fragment of the proligerous pellicle is crowded with incalculable numbers of molecules, for which he contends, Pasteur's germs are wholly inadequate to account. The notion that the molecules of the pellicle multiply by division he considers opposed to the fact that they always appear before the vibriones, and evidently unite to produce these: further, he says, "if the primary molecules on the surface of an infusion possess the property of dividing, they cannot at the same moment possess the property of elongating and forming filaments. The one function is subversive of the other. While then a cell or vibrio may possess the property of growth and division, these two functions must be exercised at different periods of time, so that, in reference to the early stage of formation, if the molecules divide, bacteria and vibrios could not be formed. A mass of vibrionic molecules is not a compound organism; it is a mere aggregation of similar simple elements. Each of these in passing through certain phases of development may be arrested, or reach maturity at various periods, so that we frequently see different forms present at one time; but that the same forms and the same stages of growth should exhibit directly opposite functions, is surely not in accordance with physiological knowledge." Therefore his conclusion is that the vibriones and other filaments are evidently formed from the molecules, and not the molecules from the filaments. He has also performed numerous experiments, with a view to determine whether or not it be possible to prevent the development of infusoria in a fluid by means calculated to destroy germs. These experiments were similar to those performed by Schutze, Schroeder and Dusch, and others, with this difference, that he in every case used nearly all the agents which have been proposed to destroy germs. These experiments have convinced him, that although means be used sufficient to destroy germs in an infusion and in the air in contact with it, infusoria are developed notwithstanding. In conclusion, he points out that these facts and arguments are hostile to the doctrines "omne vivum ex ovo," "omne cellula e cellula," and lastly directs attention to many circumstances which show that organic forms are first produced, and vital properties are afterwards added to them.

Muscle.

PRODUCTION OF HEAT DURING RIGOR.—From careful thermoelectrical observations on the muscles of frogs and fishes, Schiffer (Preliminary communication, *Centralblatt*, 1867, p. 849) finds that heat is

generated during the passage of the muscle into rigor mortis. According to this observer, a similar phenomenon accompanies the coagulation of the blood.

Movements of Sensitive Plants not due to Contractile Tissue.

Dr Paul Bert (*Journal de l'Anat. &c.*, 1867, p. 534—552) has with great care examined the movements of the sensitive plant (Mimosa pudica). He thus summarizes his results :—

1. The primary leaves of the sensitive plant, after being lowered during the night, raise themselves, before morning, to somewhat above the position they maintain during the day.

2. The motor-swellings placed at the base of the petioles may be regarded as springs that tend to impel the parts they move in a direction opposite to that of the position of the swellings.

3. Movements occur on account of the loss of force in one of the springs; no increase of force having been acquired by the opposing spring, but, perhaps, even loss.

4. There is no contractile tissue to cause movements.

5. The night movements are due to an increased tension of the motor-swellings. In the primary petioles, the superior spring increases its energy during the night; the inferior, after being slightly weakened, also becomes in turn more powerful, and the position of the petioles at different periods of the night depends on the relative strength of these two springs.

6. The quick movements that follow excitations, and the slow spontaneous ones, that constitute the daily oscillations, are totally distinct phenomena. Ether distinguishes the one from the other; for it destroys those movements that are quickly caused by excitation, while it does not affect those that occur spontaneously.

7. The latter class of movements require some previous modification in the afflux of fluid to the parenchyma of the swellings. The former are not yet connected with any antecedent phenomenon.

8 and 9 are occupied with the resemblances and distinctions between these movements and those of animated beings.

Animal Electricity.

Du Bois Reymond (*Reichert's Archiv*, 1867, pp. 417—497) gives the results of numerous measurements of the electromotive power of muscles and nerves, by means of his modifications of Poggendorf's method of compensation in the measurement of electrical forces. Among other things, he finds that the state of nerves in electrotonus is not a state of equilibrium, but of constant change as regards the electromotive power. Immediately on closing a continuous current sent through a nerve, the electromotive power of the anelectrotonic tract is greatly increased, but it afterwards gradually diminishes, the reverse is the case in the cathelectrotonic portion. Pflüger had previously observed that the changes in irritability were most marked at the moment of closing the polarising current, and that they soon

afterwards gradually became less pronounced. Former researches by Du Bois Reymond showed that in addition to muscles and nerves, glands generate electrical currents. The current which he obtained from the mucous membrame of the frog's stomach was three times as strong as that from the frog's skin. He failed to find any current between venous and arterial blood when they are brought in contact, as affirmed by Scoutetten. He also gives numerous and varied experiments to show that the electrical currents of muscle and nerve are not due, as some have supposed, to external chemical action.

DR FRASER'S REPORT.

Physiological Action of Medicinal and Poisonous Substances.

Bromide of Potassium.—An experimental research of great merit has been communicated to the Therapeutical Society of Paris by MM. Martin-Damourette and Pelvet (*Bulletin Général de Therapeutique*, 1867, p. 241 and p. 289) on the physiological action of bromide of potassium. Their object is the laudable one of elucidating the exact *modus operandi* of this remedy, and for this purpose they have performed numerous experiments of a varied character. Among their conclusions, the following seem to us the most important:—1. The effects of bromide of potassium are always *direct*, that is, due to contact with the tissues, whether at the region of application, or in the parts of the system to which it is carried by the circulation, or in the organs by which it is eliminated. 2. It has no *elective* action: certain systems are, however, affected before others. Thus, the sensory nerves lose their properties before the motor, the latter are affected before the spinal cord, and the spinal cord before the muscles. 3. The heart's action is destroyed at a late stage, and its contractions are frequently the only evidence of the vitality of the animal. 4. The respirations are affected in a secondary manner only; they cease at the time of death in birds and mammals, while their continuance in frogs is dependent on the rapidity of the other effects. 5. The minute bloodvessels contract immediately, in the region of injection, and later, throughout the organism, and this contraction is succeeded by dilatation. 6. In warm-blooded animals, the temperature falls very sensibly; at first, in the region of injection, and then in every part of the body. This difference depends on the effect on the minute blood-vessels, which is at first a local, and then a general one. 7. The secretions of the glands are diminished in proportion to the contraction of their blood-vessels. 8. The anaphrodisiac power of bromide of potassium is due to contraction of the minute afferent arteries of the *corpus cavernosus*. 9. It is not a poison of any special tissues or systems, it kills all, nerves and muscles; and it may therefore be defined as a general nervo-muscular poison.

Chloroform.—It was suggested to MM. Onimus and Legros by the results they had obtained in examining the effects of constant electrical

currents on the heart and its nerves (see Onimus on this subject, p. 407 in Dr Rutherford's Report of the present number) that such currents might prove efficient in stimulating the heart's action after its paralysis by chloroform inhalation. They have, accordingly, carefully investigated the subject (*Comptes Rendus*, Mars 9, 1867). They assert that in chloroform syncope there is more or less paralysis of the muscular fibres of the heart. The means hitherto recommended to treat this condition, such as artificial respiration, flagellation, and aspersion with cold water, are insufficient, as they do not directly influence the muscular action of the heart. Interrupted currents of electricity should not be used, as they diminish and even stop the respiratory and cardiac movements. The value of continuous electric currents was tested by experiments on dogs, rabbits, rats, and frogs, in the following manner. A rat was placed under a glass cover along with a sponge saturated with chloroform. Its respirations gradually became jerking and, in one minute, they had nearly ceased, while the animal was now completely anæsthetized. It was left for other thirty seconds under the glass cover, and, after being withdrawn, it was left untouched for another thirty seconds. No cardiac action was now perceptible. A continuous electric current was then passed from the rectum to the mouth; nothing was observed for several seconds, when the heart's beats reappeared, and then imperfect respiratory movements occurred, which, by and by, became quite normal. The electralization was now stopped, and the animal gradually recovered. Even when left for two minutes in a state of apparent death, the application of a continuous current resuscitated the animal. If an interrupted current were employed in place of a continuous one death always occurred; but if the former had been employed for only a short time life could still be restored by the use of a continuous current. The experiments on frogs were of great interest, as the various stages of the effects could be distinctly recognised, especially if the heart were previously exposed. As the exhibition of the anæsthetic was continued, the beats diminished in force and number and then ceased; if a continuous current were now used, the beats recommenced. A frog was left to itself for twenty-four hours after complete chloroform anæsthesia; the heart was then quite immobile, and although a continuous electric current could not cause any contractions of the voluntary muscles, it caused a renewal of the heart's action.

BICHLORIDE OF METHYLENE.—Dr Richardson proposes bichloride of methylene as a substitute for chloroform. His statements of its effects are thus summarised in the *Lancet* (Oct. 1867, p. 524):—Its action is more gentle but as efficient as that of chloroform, and it produces less struggling and less vascular excitement. Its narcotic effects are equally prolonged, and it interferes with muscular irritability less than any other anæsthetic. Vomiting is sometimes produced by it. When given in fatal quantity, it kills by equally paralysing the heart and the respiration.

PRUSSIC ACID.—Preyer (*Virchow's Archiv*, 21 Hft., 1867, pp. 125—141) finds that the blood of animals killed with prussic acid does not exhibit the spectrum of the compound of HCN with O-Hb that he has discovered. Notwithstanding the rapidity with which this poison acts, the venous blood is sufficiently modified to exhibit the spectrum of reduced hæmoglobin, and thus resembles the blood of animals that have been asphyxiated. Preyer finds that the slowing and arrest of the heart's action, which is usually induced by this poison, does not take place after division of the vagi nerves. He describes a series of experiments which show that artificial respiration is of the greatest use in the treatment of poisoning by prussic acid. Rabbits often recover after the appearance of convulsions, and after nearly complete arrestment of the respiratory and cardiac movements, provided the artificial respiration be continued for a considerable time. Other researches into the effects of prussic acid on the blood in relation to its influence on the spectrum have been published by Schoenbein (*Neues Repert. für Pharm.*, 1897, p. 606), and by Hoppe Seyler (abstract in *Chem. Centralblatt*, 1867, p. 695).

AROMATIC ACIDS.—O. Schultzen and C. Gräbe (*Archiv f. Reichert u. Du Bois Reymond*, 1867, pp. 166—172) have investigated the changes that some of the aromatic acids undergo in the system. It is known that several of these acids cause the appearance of hippuric acid in the urine. This is true of benzoic acid (Wöhler), salicylic acid (Bertegnani), bitter almond oil (Frerichs, Wöhler), chinic acid (Lautemann), and β toluic acid (Krant). The authors have now examined some substances which were supposed to be unacted on in the system. They found that when chlorobenzoic acid was taken in doses of thirty grains a salt appeared in the urine, which was proved to be chlorohippurate of calcium ($Ca\,(C_9\,H_7\,ClNO_3)_2 + 4H_2O$). Anisic acid, or methyl-oxy-benzoic acid, was changed unto methyl-oxy-hippuric acid ($C_{10}\,H_{11}\,NO_4$). Cinnamic and mandelic acids caused the appearance of hippuric acid in the urine.

COCA.—A valuable monograph has been published by Dr Thomas Moréno y Maïz on the chemical and physiological properties of Erythroxylum coca (*Recherches Chimiques et Physiologique sur l'Erythroxylum Coca*, Paris, 1868). Small doses appear to have no effect on the urine and but little on the circulation. The effects on nutrition were partially examined; and this portion of the investigation is of great interest as the natives of Peru and of other parts of South America employ coca as a masticatory during long and toilsome journeys, and are able, while using it, to dispense with food almost entirely, and for several days. Dr Moréno believes that if coca is able to appease hunger, it is not alone sufficient to sustain the system. In some experiments in which birds and mammals were subjected to a somewhat insufficient diet containing a considerable proportion of coca, he found that death was not retarded, and that even the vital processes of disintegration were apparently unchecked. In examining the action on muscles and nerves, the acetate of the

active principle, cocaïne, was used. One of the first symptoms that was produced by this salt was excitation of the muscles, and this was followed in succession by exaggeration of sensibility, flaccidity of the muscles, unconsciousness, and, if the dose were a large one, by loss of sensibility. It is somewhat singular that the motor power is never lost, in non-fatal experiments, although it is the first to be diminished; while the sensibility is completely destroyed, although it is not diminished until a late stage of the poisoning. When large doses are given, the condition of increased sensibility manifests itself by tetanic convulsions, which occur both spontaneously and on the slightest excitation, and which are similar to those caused by strychnia (and by caffein and thein). When small doses are given, besides distinct increase of sensibility, the pupils dilate, and the power of co-ordinating the movements is lost. Dilatation of the pupils also occurs with large doses.

GUARANA; fruit of *Paullinia sorbilis*.—Dr Paul Montegazza has acquired a wide fame as the author of an important research on Coca. He has lately examined the action of Guarana, a substance extensively used in South America for the same purposes as tea, coffee, cocoa, &c. (*Bulletin Général de Thérapeutique*, 1867, p. 169). Among his conclusions are the following:—1. Guarana does not suspend the ciliary movements in the embryo of the frog, in which it differs in action from coffee. 2. When small quantities (two or three grains) are given to frogs, irregular movements and then a condition of increased excitability occur. With large doses, death is produced by tetanus, but the spasms are less violent than with caffein. 3. In frogs, the heart's contractions are diminished in frequency, while they are augmented in force. 4. In lizards and fishes, the action is analogous to that on frogs. 5. Birds are killed by small doses with tetanic symptoms, and, in the autopsis, congestion of the brain and meningeal hæmorrhage are found. 6. Eighty grains produce in rabbits stupor, and languor merely; and the same effects are produced in small dogs by an ounce. 7. Doses of from seven to sixty grains cause the following effects on man; cheerfulness, restlessness, hyperæsthesia of the senses, mental activity, sleeplessness, a slight diminution in the rate of the heart's action, loss of appetite, urticaria, prurigo and spasm of the bladder.

STRYCHNIA.—Jacobowitsch, and, afterwards, Roudanowsky and others have attributed the death that is caused by strychnia to various lesions of the spinal cord, such as prolongations and ruptures of cells. Their views have been opposed by many physiologists, but principally by M. Vulpian of Paris. This distinguished *savant* now advances a new argument, which is derived from an interesting observation he has recently made (*Archives de Physiologie*, 1868, No. 2, p. 306). On the 20th of Dec. 1867, he introduced a few crystals of hydrochlorate of strychnia under the skin of a frog's leg. This quickly produced convulsions, which were soon followed by a condition of flaccidity. On the following day, convulsions again

appeared, and the animal presented all the appearances of violent strychnia-action. Several days afterwards, this condition continuing, Vulpian excited the frog repeatedly and until flaccidity was again caused by exhaustion; the characteristic strychnia phenomena, however, reappeared in about half-an-hour, and they continued until the 23rd of January, 1868, when death occurred. On examination, it was found that the nerves were in a perfectly normal state; that some very slight and unimportant changes had occurred in the muscles; and, by the aid of careful inspection with the microscope, that both the grey and white substances, the pigment, and the blood-vessels of the spinal cord were absolutely normal. Thus, the various structures in the spinal cord had been under the influence of strychnia for more than a month, and yet no modification could be discovered. Vulpian considers this a strong proof of the erroneousness of the theory advanced by Jacobowitsch. A curious observation has been made by Dr Geube of Ulm (*Archiv f. Reichert u. Du Bois Reymond*, 1867, p. 629), on an effect of artificial respiration on the action of strychnia. When this is kept up so as to produce an abnormally high oxygenation of the blood, the convulsions of strychnia are either altogether prevented or very greatly diminished. Whether a certain deficiency of oxygen is necessary for the production of strychnia convulsions, as for some other reflex manifestations of the cord, or whether lowering of the temperature—through the excessive respiration—is the chief cause in preventing the convulsant action of strychnia, Geube considers cannot be determined without further researches.

OPIUM ALKALOIDS.—Baxt has examined the physiological action of several of the opium alkaloids (*Wiener Acad. Sitzungbericht*, LVI., p. 189, and *Centralblatt*, 1867, p. 767). He confirms numerous previous observers by finding that thebaia produces the same effects as strychnia. He differs from Claude Bernard in asserting that papaverine has principally a narcotic action; the French physiologist having found that convulsions were the most prominent of the symptoms caused by this principle. Baxt believes that porpyroxine possesses both a narcotic and a convulsant action.

SULPHATE OF ATROPIA.—A very elaborate research was made by the late Professor A. V. Bezold and by Dr Friedr. Bloebaum into the action of Sulphate of Atropia (*Untersuchungen aus dem Physiologischen Laboratorium in Würzburg*, 1[tes] Heft, 1867). The more important of their results may be thus stated:—1. *Action on motor nerves and on striated muscular fibre.* Sulphate of atropia does not affect the muscular irritability, but it diminishes the irritability of the peripheral terminations of the motor nerves, and also of the nerve trunks: in one experiment on a frog, complete paralysis of the motor nerves was caused. This action is not an early and prominent one as in curare-poisoning, for it appears only after a large dose of the poison has acted for a long time. 2. *Action on sensory nerves.* The authors are inclined to think that this poison

paralyses the cutaneous terminations of the sensory nerves, but their examination of this effect is not yet concluded. 3. *Action on the Circulation.* In rabbits, small doses (between $\frac{3}{100}$th and $\frac{4}{100}$th grain) increase the blood-pressure and the frequency of the heart's action; medium doses (between $\frac{1}{10}$th and $\frac{2}{10}$ths grain) produce transitory lowering of the blood-pressure and quickening of the heart's action; large doses (one grain and a half) produce sudden stoppage of the heart's action. In dogs, almost any dose quickens the heart's action, and by appropriate doses the beats may be tripled and even quadrupled. When the heart's action is quickened, irritation of the peripheral portions of the divided vagi does not arrest or at all affect it; the vagi nerves are, therefore, paralysed by this poison. The vagi may be paralysed in rabbits and dogs by doses too small to affect any other nerve (about $\frac{7}{1000}$ths of a grain for rabbits, and $\frac{9}{1000}$ths for dogs). 4. *Action on Respiration.* The respirations are at first increased in frequency and then diminished. 5. *Action on unstriated muscular fibre.* The intestines, bladder, and uterus lose their irritability, partially, when small doses, and, completely, when large doses are given. They are also paralysed when large quantities are topically applied. 6. *Action on the Iris.* Von Bezold and Bloebaum believe that atropia never increases, but always diminishes the excitability of the muscular fibres and nerves in the iris. It first paralyses, more or less completely, the end-organs of the oculo-motor nerve, and then diminishes the excitability of the circular muscle. The effect on the fibres of the radiating muscle is less powerful, because the end-organs of the sympathetic nerve by which it is supplied are less affected than those of the oculo-motor nerve in the circular muscle.

BELLADONNA AND CONIUM.—We learn the following results of Dr J. Harley's researches from an abstract of two of the Gulstonian lectures he lately delivered (*Med. Times and Gaz.*, March 21, 1868). Their principal value depends on the care with which the effects on man were observed. He finds that belladonna is a powerful cardiac stimulant; in a few minutes after the administration of a small dose, the pulse-beats are suddenly accelerated to double their former number, while their volume and force is augmented. This agrees with Von Bezold and Bloebaum's results on lower animals (see 'Sulphate of Atropia'). It acts also as a diuretic, and it promotes oxidation in the system. Small doses of conium were found to depress, in a marked manner, the power of muscular action. Besides, the eyes were remarkably affected; there being depression of the moto-stimulant function of the third nerve, with sluggish movements of the eyes, imperfect adjustment of the refracting media, and, sometimes, strabismus. The action of a full dose was to cause sleep. Conium reduces the irritability of the spinal cord, it does not appear to interfere with the sensory nerves, and it has no direct action on the cerebrum. Harley, on the whole, confirms the results of previous observers.

VERATRUM VIRIDE AND V. ALBUM.—Dr Oulmont (*Neues Repertorium für Pharmacie*, 1868, Bd. XVII. Heft 3, p. 177) publishes some interesting observations and experiments made on man, dogs, rabbits, and frogs, with Veratrum viride. When small, non-fatal doses were given to the lower animals, the symptoms were localized chiefly in the digestive, respiratory, and circulatory systems, and on the general force. In the digestive system, they consisted of nausea, of vomiting, which sometimes lasted for twenty hours, and of diarrhœa. If doses sufficient to cause death were administered, these symptoms occurred in an excessive degree, but no signs of inflammation could be discovered. The respirations were powerfully affected at an early stage: they were, sometimes, unequal and irregular; they were, sometimes, diminished in number to two or even one in the minute; and, in frogs, they were, sometimes, altogether stopped. The rapidity of the circulation was soon diminished, the pulse being often reduced within fifteen minutes by from twenty to forty beats in the minute. The effect on the temperature was somewhat less marked. It falls two, three, or five degrees in from an hour and a half to two hours, and it may remain at this reduced point as long as twenty-four hours. The hyposthenic action is nearly immediately produced, and the weakness and sinking of the general force are prominent effects of large doses; but even when these are sufficient to cause death, neither muscular stiffness nor convulsions ever occur. The latter symptoms, however, are the special characteristics of the action of veratria. For the purpose of comparison, Oulmont examined the action of Veratrum album. He found that it is distinguished from that of V. viride by the greater violence of its effects on the digestive system, where it always produces inflammatory lesions, and by the greater rapidity of its action. Finally, the action of the alkaloid veratria, was investigated with the somewhat unexpected result, that it is not the true active principle of veratrum. Some V. viride was completely freed from the alkaloid, and an ordinary dose given to an animal; the effects were in all respects the same as those of the usual preparations. Oulmont concludes that Veratrum viride is a cardiac poison analogous to digitalis, from which it is distinguished by its extraordinary rapidity of action. This investigation is of special interest, as V. viride has been introduced into the British Pharmacopœia, while, until now, a considerable amount of uncertainty has existed as to its exact physiological action.

SAPONINE is a neutral principle derived from the common soapwort (Saponaria officinalis), from the horse-chestnut (Æsculus hippocastanum), from the corn cockle (Agrostemma githago), and from a number of other plants. Its physiological action has been lately studied by M. Eug. Pélikan (*Journ. de Pharm. et de Chim.* 1867, p. 465) with some interesting results. He found that when a small dose was introduced into the cellular tissue of a frog's leg, the muscles in the immediate neighbourhood became paralysed. When a large dose was similarly exhibited, the paralysis became more general and

it involved, first, all the voluntary muscles of the body, and afterwards the heart. By localized poisoning, he has demonstrated that saponine acts on the system by destroying the contractility of muscular fibre, and by paralysing the sensory nerves. Its topical application was followed by paralysis with subsequent rigidity of the muscles, and Pélikan therefore considers that this local action places it in an analogous position to atropia and physostigma, which have both special actions on the iris.

COUNTER-ACTIONS.—Dr B. W. Richardson considers that nitrite of amyl is a direct physiological antagonistic to strychnia (*Brit. and For. Medico-Chir. Review*, Jan. 1868, p. 264). He has arrived at this conclusion from several experiments on frogs, in which he found that the convulsant action of strychnia could be delayed or prevented by the previous exhibition of nitrite of amyl, and also completely stopped by its exhibition at a late stage of the poisoning. Arnstein and Sastschinsky, in a preliminary contribution (*Centralblatt*, 1867, p. 628), affirm that Calabar bean increases the irritability of the cardiac terminations of the vagi, even after their division previous to the administration of the poison. On the other hand, atropia is said to paralyse the cardiac terminations of these nerves. In some experiments on rabbits and guinea-pigs, Arnstein and Sastschinsky found that the paralysis produced by atropia could be removed by Calabar bean, and that the increased irritabity produced by Calabar bean could be removed by atropia.

VACCINE VIRUS.—M. Chauveau has published an investigation (*Comptes Rendus*, Paris, 10 Février, 1868) undertaken to determine if the activity of vaccine virus resides in all, or in one or more, of the elements of which it is composed. His method was to test experimentally the various elements after they had been isolated from each other as completely as possible. This virus is composed of, 1st, the *serum*, an albuminous fluid holding the various soluble substances in solution; and 2nd, the *solid elements*, consisting of *leucocytes* and of *elementary granulations*, both of which are suspended in the serum. The *leucocytes* were separated by diluting the virus with 10 times its weight of distilled water (which does not diminish the activity) and allowing the mixture to remain at rest for 24 hours. By this time, the *leucocytes* had subsided to the lower portion. The upper portion, which was entirely free from them, was found to be as active as the original virus; and, therefore, the activity does not reside in the *leucocytes*. Chauveau next obtained the *serum* free from *granulations*, by a process of diffusion. He placed a little virus in a small test-glass and then poured some distilled water into the glass so as to form a layer over the virus, with which, by a little care, it was prevented from mixing. In about 48 hours the top layer was found to contain a proportion of all the soluble substances of the serum, while it was entirely free from any of the solid elements. When some of this upper layer

was tested by inoculation it was found to be perfectly inert. The *serum* is not, therefore, virulent, and the activity of the virus must reside in the *elementary granulations*. A second communication (17 Février) is occupied with an examination of the possible fallacies in the processes by which these results were obtained. These are most satisfactorily explained, and they need not all be detailed here; but one may be referred to as being practically important, namely, the effects of dilution in modifying the activity of vaccine virus. Chauveau found that dilution of the virus with as much as 15 times its weight of distilled water did not diminish the original activity. When it was diluted with 50 times, it usually failed when inoculated; though, on one occasion, a dilution with 150 times was successful. From 15 to 50 times, sometimes failed and sometimes succeeded; but the failures were more frequent the greater the dilution. This is explained by the greater chance of *elementary granulations* being about the greater the dilution.

DR GAMGEE'S REPORT.

Physiological Chemistry.

BLOOD.—A. Schmidt (*Centralblatt*, 1868, No. 3) has obtained results which appear conclusively to show that oxidation does take place within the blood itself. He finds that venous blood contains substances having the power of permanently retaining a portion of the oxygen which it absorbs. Blood which was almost free from oxygen was brought in contact with a measured volume of this gas, and the exact amount of absorption determined. The gases of the blood were then removed with the mercurial pump, and it was invariably found that less oxygen could be thus removed than had been absorbed; the quantity of oxygen which had been retained or used up amounted to from 1·25 to 3·32 volumes for every 100 volumes of blood. The author also caused defibrinated arterial blood to circulate through the vessels of a kidney which had just before been removed from a dog and placed in water of the temperature of the body. Under these circumstances the circulating blood was deprived of its loose oxygen, exhibiting the spectrum of reduced hæmoglobin, in a period twenty or thirty times shorter than was required for the same blood if not made to circulate through the kidney. The blood which had thus circulated possessed, to a high degree, the power of permanently retaining a portion of the oxygen with which it was brought in contact.

A. Schmidt in another paper (*Virchow's Archiv*, Feb. 1868) shows the insufficiency of the methods of research by which Pokrowsky has attempted to disprove the power which the blood appears to possess of ozonizing the atmospheric oxygen. As Pokrow-

sky had not succeeded in observing the fact which Schmidt first discovered, viz. the blueing of guiacum by blood, Schmidt states the conditions which must be observed in order to notice this beautiful phenomenon. Filtering paper is soaked in tincture of guiacum and then hung up until the alcohol has evaporated. When such paper is touched with a drop of a solution made by mixing blood with about twenty times its volume of water, a blue colouration appears at the margins of the drop.

J. Gwosdew (*Archiv, J. Reichert und Du Bois Reymond*, 1867, p. 635) has examined the spectrum of the blood of asphyxiated animals, using precautions to prevent the access of oxygen to the blood under examination. In some cases the bands of O – Hb had completely disappeared and were replaced by the broad band of reduced hæmoglobin. In others the bands of O – Hb were exceedingly faint.

Preyer (*Virchow's Archiv*, Sept. 1867, pp. 125—141) confirms his previous statements concerning the action of hydrocyanic acid and cyanide of potassium in modifying the spectrum of blood. He believes that these substances form compounds with reduced hæmoglobin as well as with the oxidized substance. He has succeeded in obtaining the compound of HCN with O – Hb in a crystalline condition, by heating Prussic acid with a solution of hæmoglobin at a temperature of 30° C. until a spectrum similar to that of reduced hæmoglobin is observed. The spectrum seen under the circumstances is that of the Prussic acid compound. The solution in which this change has taken place becomes turbid; it is filtered and the filtrate evaporated at a temperature varying between 10° and 25° C., when crystals are obtained which are isomorphous with those of O – Hb. Their spectrum is however marked by a single broad band, and when distilled with dilute phosphoric acid they yield Prussic acid. The Prussic acid compound of hæmoglobin does not appear to possess the property of ozonizing the atmospheric oxygen. The blood of animals poisoned by Prussic acid does not possess the spectrum of the HCN compound, but is generally free from oxygen, and, like that of asphyxiated animals, exhibits the absorption spectrum of reduced hæmoglobin.

Eulenberg and Vohl (*Virchow's Archiv*, Feb. 1868, p. 161) state that when blood confined over mercury is heated to 100° C. a large quantity of gas is evolved, which is completely reabsorbed when the blood cools. The authors describe an instrument which they propose to call blood-gas measurer or Pneumathæmometer, for the purpose of ascertaining the volume of the gases evolved when blood is heated to 130° C. This instrument is a modification of Geissler's alcoholometer. Believing apparently that this method of research is possessed of some value, the authors describe a grossly crude method of ascertaining the relative quantities of the respective gases evolved. They also describe the results of a series of superficial experiments on the changes induced in the spectrum by the addition of a great variety of different substances to blood.

N. Zuntz (*Centralblatt*, 1867, No. 34) has discovered that the alkalinity of the blood undergoes, immediately after its withdrawal from the body, an enormous diminution. The author has made a most useful discovery which will undoubtedly be appreciated by those who are investigating the blood, viz. that the reaction of blood may be readily ascertained by placing a drop upon litmus paper which has been soaked in solutions of chloride or sulphate of sodium. Under these circumstances the colour which the test paper assumes at the margin of the drop indicates in a beautifully clear manner the reaction of the blood. When a drop of blood is placed on test paper which has not been treated as Zuntz recommends, the red colour completely masks the reaction. Having thus found a means of readily and accurately ascertaining the reaction of blood, the author has determined its alkalinity by titrating it with a very weak solution of phosphoric acid. The solution employed was of such strength that one cubic centimètre neutralized 0·005 grm. of Na_2CO_3. He found that blood which on leaving the body was kept for a very short time at the temperature of the latter, rapidly became less alkaline. Thus in one experiment the alkalinity of the blood of a pig corresponded to 0·33 grm. of Na_2CO_3 for every 100 C. C of blood. After being digested for two minutes at the temperature of the body the alkalinity only equalled that of 0·17 grm. of Na_2CO_3 for every 100 C. C of blood.

Bile.—Thudicum (*Proc. R. S. L.* 1867, No. 97, p. 215) has published the results of an investigation on the chemical nature, composition, combinations, and metamorphoses of the colouring matters of the bile. The first part of the paper treats of cholophaeine and its compounds. To cholophaeine, or as it has also been called bilirubine, the author assigns the formula $C_9H_9NO_2$, which differs considerably from that proposed by Staedeler, viz. $C_{16}H_{18}N_2O_3$. Cholophaeine forms silver, barium, calcium, and zinc salts. A new reaction of cholophaeine is described which consists in dissolving the dry powder in sulphuric acid. A splendid green substance is produced to which the author gives the name of cholothalline, and the formula $C_9H_{11}NO_3$. When treated with nitric acid cholophaeine also yields a blue coloured substance (cholocyanine). The second part of the paper treats of biliverdine, which Thudicum obtained by dissolving cholophaeine in solution of carbonate of potassium and warming it, whilst a current of air was passed through it. When the solution has become green it was precipitated by hydrochloric acid. The precipitated biliverdine is a non-crystalline, splendidly green substance, easily soluble in alcohol, and not possessing any characteristic absorption spectrum. It is a product of the oxidation of cholophaeine,

$$C_9H_9NO + 2O = C_8H_9NO_2 + CO_2.$$

Besides cholophaeine, human bile contains, according to Thudicum, another brown colouring matter, bilifuscine, of which he promises the description in a future paper.

J. Dogiel (*Journ. f. pract. Chem.*, LI. 298) has found acetic and propionic acid in the bile.

SALIVA.—De Luca and Panceri (*Comptes Rendus*, 30 Sept. 1867, p. 577, and 28 Oct. 1867, p. 712) have analyzed the secretion of the salivary glands of Dolium galea, a mollusc inhabiting the Mediterranean. The salivary glands of this animal are of extraordinary size. Thus one specimen of dolium, examined by the authors, which weighed 2005 grammes, had salivary glands which weighed 150 grammes. Boedeker showed that the secretion of the glands contained free sulphuric acid, and the statement is now fully confirmed by De Luca and Panceri, who have found as much as four parts of free sulphuric acid in a hundred of the salivary secretion of dolium! The gland substance when brought in contact with the acid secretion evolves large quantities of carbonic acid; thus the glands of the specimen weighing 2005 grammes yielded 343 cubic centimètres of CO_2. The authors have moreover discovered free sulphuric acid in the glands of the following Gasteropoda: Tritonium nodiferum, L. K.; Tritonium corrugatum, L. K.; Tritonium hirsutum, Fab. Col.; Cassis sulcosa, L. K.; Cassideria echinophora, L. K.; Murex trunculus L.: Murex brandaris, L.; Aplysia camelus, Cuv., &c. The authors are prosecuting their researches with the object of discovering whether the free sulphuric acid is due to the oxidation of the sulphur of matters containing this element (unoxidized), or whether it is produced from the sulphates of sea-water by a process of electrolysis.

URINE.—Under the term Uromelanine Dr Thudicum describes (*Proc. R. S.*, 1867, No. 97, p. 217) a product of the decomposition of the yellow colouring matter of urine (urochrome). The atomic weight of uromelanine (733) is higher than that of any other product of the decomposition of animal matters. Uromelanine contains neither sulphur nor iron. It is, according to Thudicum, probably derived from hæmoglobin, though not from hæmatin, than which it has a higher molecular weight.

LECITHIN.—Under the name of Lecithin, Dr Diakonow has described (*Hoppe-Seyler's Med. Chem. Untersuch.* 2 Heft, p. 221. *Centralblatt*, 1868, No. 1) a substance which Hoppe-Seyler and he have separated from the yolk of the egg; this substance is rich in phosphorus, and is closely related to protagon. The brain contains much lecithin. In order to obtain lecithin from the brain this organ is well broken up and digested with absolute alcohol at a temperature of 40° C. The alcoholic solution is afterwards cooled to 0° C, when a precipitate separates. This precipitate is collected on a filter, washed with a little cold absolute alcohol, and treated with ether. A portion of the precipitate dissolves in ether, whilst that portion which consists of protagon remains undisturbed. The ethereal solution is evaporated and the residue left is dissolved in a little absolute alcohol heated to 40° C. The alcoholic solution on being cooled to

$-7°$ C or $-10°$ C, deposits the new substance, lecithin. This substance is amorphous, hygroscopic, cannot be powdered; when agitated with water it forms an emulsion with it. When burnt on platinum it leaves as residue pure phosphoric anhydride (?). Diakonow assigns to lecithin the formula $C_{44}H_{90}NPO_9 + Aq$. When boiled with a solution of caustic baryta it is readily decomposed; a precipitate of stearate of barium falls, whilst the supernatant fluid contains glycerophosphate of barium and neurin (hydrate of ethoxyl-trimethyl-ammonium). These substances are the sole product of the reaction,

$$C_3H_9PO_6 + 2(C_{18}H_{36}O_2) + C_5H_{15}NO_2 - 3H_2O = C_{44}H_{90}NPO_9.$$

Lecithin is, according to Diakonow, distearyl-glyceryl-phosphate of ethoxyl-trimethyl-ammonium.

Neurine.—Wurtz (*Comptes Rendus*, lxv. Dec. 1867, p. 1015) has effected the synthesis of neurine by heating in a sealed tube trimethylamine with chlorhydric glycol. As a product of the reaction he obtained crystals of the chloride of ethoxyl-trimethyl-ammonium (neurine), which when decomposed with oxide of silver yielded free neurine.

$$C_2H_4\left\{\begin{matrix}OH \\ Cl\end{matrix}\right. + \left.\begin{matrix}CH_3 \\ CH_3 \\ CH_3\end{matrix}\right\}N = \left.\begin{matrix}CH_3 \\ CH_3 \\ CH_3 \\ C_2H_4(OH)\end{matrix}\right\}NCl.$$

Urea.—Kolbe, at a recent meeting of the Chemical Society, stated that he had succeeded in obtaining urea from carbonate of ammonium, by heating the latter substance in sealed tubes to the temperature at which urea commences to decompose. The details of this remarkable synthesis are as yet unpublished. Wanklin and Gamgee (*Journal of Chemical Society*, Jan. 1868, p. 25) have examined the action of permanganate of potash on urea in strongly alkaline solutions. They find that when this substance is heated in sealed tubes with a large excess of alkaline permanganato, it yields nearly the whole of its nitrogen as nitrogen gas, whilst with less permanganate it gives part of its nitrogen as gas and part as nitric acid. Mr T. Williams, in a note on the preparation of urea (*Journal of the Chem. Soc.*, Feb. 1868), recommends that cyanate of lead should be substituted for the cyanate of potash, which has hitherto been always employed. The former salt can easily be prepared pure, is perfectly stable, and when dissolved in water and treated with sulphate of ammonium readily furnishes urea.

Sarcosine.—A. Buliginsky (*Med. Chem. Untersuch.* pp. 255—256) states that alcoholic solutions of sarcosine yield with chloride of zinc a chrystalline precipitate ($C_3H_7NO_2 + ZnCl_2$) which is soluble with difficulty in alcohol, but readily in water; the latter character distinguishes it from the compound of chloride of zinc with creatinine.

ALBUMINOID SUBSTANCES.—Professor Schwarzenbach stated some time since (*Annal. de Chem. u. Pharm.* XXXIII. 125) that platino-cyanide of potassium forms with the albuminoid bodies compounds of definite composition. The compound with casein yielded 11 per cent. of platinum, whilst that with albumen yielded 5·5 per cent. Diakonow (*Med. Chem. Untersuch.* 2 Heft, 228) has however repeated the experiments of Schwarzenbach, and states that the amount of platinum in the compounds varies greatly. Schwarzenbach in a more recent paper (*Zeitschrift für Chemie von Beilstein, Fittig, und Hubner*) gives the result of his analyses of the compound of platino-cyanide of potassium with vitellin, globulin, syntonin, and fibrin. Vitellin consists, according to this author, of a mixture of casein and albumen, and accordingly yields two different platinum compounds, of which the one contains about 11 per cent. of Pt, the other 5·5. Globulin, syntonin, and fibrin, all form compounds containing 5·5 per cent. of platinum.

NOTICES OF RECENT DUTCH AND SCANDINAVIAN CONTRIBUTIONS TO ANATOMICAL AND PHYSIOLOGICAL SCIENCE. By W. D. MOORE, M. D. Dub. et Cantab., M.R.I.A. &c. &c.

1. *De Rhythmus der Hartstoonen, door F. C. Donders. Nederlandsch Archief voor Genees- en Natuurkunde*, 1865, p. 139.

On the Rhythm of the Sounds of the Heart, by F. C. Donders, M.D., F.R.S., Professor of Physiology and Ophthalmology in the University of Utrecht.

A translation in full will be found in the *Dub. Quart. Jl. of Medical Science*, XLV. 225. The author deduces the following:—

Corollaries: (1) The cardiac sounds are distinguished as I and II. The distance from the commencement of I to that of II is a, that from II to I is A. The period $P = a + A$.

(2) The frequency of the pulse being given, the rhythm of the sounds of the heart teaches us a and $a : P$, that is the absolute and the relative duration of the active part of the cardiac period.

(3) The rhythm of the sounds of the heart can be imitated by movement of the hand and so be registered.

(4) The accuracy of this method, tested by the imitation of a self-registering rhythm, has been shown to be satisfactory. The probable error is very slight; the personal error is variable with the values of P and $a : P$.

(5) In the state of rest a amounts usually to from 0·309 to 0·327 of a second, and continues tolerably equal, with different values of P.

(6) In this we have a proof, that a, the duration of the active working of the heart, has a certain independence.

(7) $a : P$ is, in the state of rest, the greater, the shorter the periods are; in young persons $a : P = 0{\cdot}404$ to $0{\cdot}482$, average 0·428.

(8) With increased frequency of the pulsations in consequence of work (rapid ascent of stairs), a on the contrary often diminishes more quickly than P, and $a : P$ therefore becomes less, the less P is.

(9) A few minutes after work is performed, the cardiac periods usually become, with strong and quick respiration, temporarily very long, but a continues in general short, so that then $a : P$ is less than ever. The independence of a is thus again demonstrated.

(10) In the standing posture a becomes perhaps relatively somewhat greater, but absolutely considerably less than in the sitting.

2. *Over de Uiteinden der Smaakzenuwen in de Tong van den Kikvorsch, door Th. W. Engelmann, Assistent bij het physiologisch laboratorium te Utrecht, Nederlandsch Archief*, 1867. On the Ter-

minations of the Gustatory Nerves in the Tongue of the Frog, by Th. W. Engelmann, Assistant in the Physiological Laboratory at Utrecht.

Three kinds of cells are described: 'cup-cells,' 'cylinder-cells,' and 'fork-cells,' as entering into the epithelium covering the circular terminal surface of the papilla. The first two he considers to be only epithelial cells of peculiar construction, the 'fork-cells' he believes to be the extremities of the Gustatory Nerves. According to him the connective tissue in the papilla consists of an under portion of loose, and an upper portion of dense tissue. The former contains the blood-vessels, the terminations of the muscular fibres, and the darkly defined nerve-tubes. The upper part, which he calls the *nerve-cushion*, contains an amazing number of extremely delicate, pale nerve fibres, forming a delicate nervous network, whence very numerous, extremely fine branches ascend in a tolerably straight direction to the free upper surface of the nerve-cushion. The continuations in the epithelium of these branches, which perforate the nerve-cushion, are the central outrunners of the fork-cells. He has not, however, succeeded in absolutely demonstrating this arrangement, but only established its extreme probability. "We see," he says, "delicate, pale nerve fibres reach in very many points the surface of the nerve-cushion; we see from this surface equally delicate, extremely numerous fibres, having the same properties as pale nerve fibres, issuing and continued directly into the substance of the fork-cells. If we now assume the existence of a connexion between the former fibres and these latter, we do only what is necessary: we assume what is by far the most probable."

3. *The Nederlandsch Archief voor Genees- en Natuurkunde* for 1867 (Deel III, 1e en 2e Afleveringen). Dr MacGillavry on the influence of the Nervus Vagus on the respiratory movements (*De invloed van den nervus vagus op de Ademhalingsbewegingen*). Dr MacGillavry's experiments were made upon rabbits, and he deduces the following propositions:—

(1) The constancy of the quantity of air (capacity of respiration) after division of both vagi, in a rabbit, does not prove that the activity of the respiratory centre has continued as great, and it consequently proves nothing against a reflex action of the vagus on the muscles of inspiration.

(2) When through electrical stimulation of the central extremity of the vagus during artificial respiration contraction of the diaphragm is produced, this contraction proves that the supply of oxygen is insufficient to cause complete apnœa.

(3) The negative results of vagus-irritation during complete apnœa are much more probably explained by denying to the respiratory centre during this condition all possibility of action, than by ignoring the reflex power of the vagus.

(4) The vagus prevents complete paralysis of the respiratory centre during the chloroformisation of rabbits, and it effects this by exciting reflex inspirations.

(5) It is very possible, and even rather probable, that hæmoglobuline not combined with oxygen, dissolved in the blood-plasma, is the principle which produces in the respiratory centre by oxidation the necessary chemical *energy*.

4. *Bijdragen tot de kennis van het mechanisme van 't lichaam, door W. Koster.* Contributions to our Knowledge of the Mechanism of the Body, by W. Koster.

I. *Pressure of the Atmosphere upon the Hip Joint.*

The following are some of the conclusions:—

"(1) The hermetical locking of the head of the thigh-bone within the acetabulum causes that, as Weber has shown, we should, without muscular action in that joint be able to carry about 14 kilogrammes [nearly 31 lbs. avoirdupois].

(2) On strong extension of the thigh the Zona Orbicularis Weberi bears, without the influence of the atmospheric pressure, the same and a still greater weight. From the physical experiments and the correct reasonings of Rose, it follows however:

(3) That during life the muscular tension and the adhesion of the surfaces of the acetabulum and the head of the femur in apposition carry the inferior extremities, so that the effect of the atmospheric pressure does not in this case come into account."

II. *The rotation of the head in the atlantico-occipital articulation.*

"The rotation to one side may be approximately stated at 75°, about $\frac{1}{10}$ taking place between the atlas and the occipital bone, $\frac{3}{10}-\frac{4}{10}$ between the dentata and atlas, and $\frac{4}{10}-\frac{5}{10}$ between the other cervical vertebræ. Schroeder van der Kolk correctly remarked, that this distribution of the rotation over the different vertebræ must certainly be important in promoting the uniform extension of the vertebral arteries, and in preventing its being excessive in any one place."

5. The same Journal contains also the following articles:—(1) A. Terné van der Heul, the Influence of the respiratory phases on the Duration of the Cardiac Periods. (2) T. Place, the Wave of Contraction of the Voluntary Muscles. (3) J. G. van der Lith, on the Descent of the Testicles. (4) Th. W. Engelmann, on Ciliary Movement.

ON THE SEAT OF IRRITATION IN THE MUSCULAR FIBRE ON THE CLOSING AND OPENING OF A CONSTANT GALVANIC CURRENT. By Th. W. Engelmann, Assistant in the Physiological Laboratory at Utrecht. Translated from the *Nederlandsch Archief voor Natuur- en Geneeskunde*, D. III. 1867.

Pflüger has shown, that on the closing and opening of a constant galvanic current, the irritation is produced, not at all points of the intrapolar part of the nerve, but only at the poles. The law runs thus: the nerve is irritated by the occurrence of katelectrotonus and the disappearance of anelectrotonus. The question was, whether in the muscular fibre too the irritation takes place on closing of the current only at the negative pole, on opening only at the positive. On this point experiments have been made by von Bezold and Aeby. Von Bezold came to the conclusion that the law established by Pflüger for the nerve is applicable also to the muscular fibre. Aeby, on the contrary, asserts that the irritation both on closing and on opening of the current takes place at all points of the intrapolar part of the muscle.

These opposite results were deduced from experiments performed by methods differing but slightly from each other. Von Bezold determined the time which the wave of contraction required for propagation from a directly stimulated portion of muscle to a more distant part of the same muscle. The moment when the contraction wave arrived there was recorded by the muscular fibre itself, with a lever raised by the shortening, upon the blackened rotating cylinder of the myographion of Helmholtz. The moment of closing or opening of the galvanic current was registered on the same cylinder. Now when the irritation with closing of the current took place at the cathode, with opening at the anode, the registering portion of muscle must contract earlier, as the cathode was further from it than the anode, and indeed as much earlier as the irritation required for transmission through the intrapolar portion of muscle. If, on the contrary, the muscle were simultaneously irritated at all parts of the intrapolar portion, a similar time must elapse on closing and on opening, between irritation and contraction, independently of the direction of the current. Von Bezold found the former; Aeby, who made the lever register not the shortening but the thickening of the muscle, observed the latter.

I am in a condition to communicate an experiment which in a simple manner solves the question.

The sartorius muscle of a frog was cleanly prepared, cut off, and suspended by means of a clamp at the upper end. If we now place, a few millimètres beneath the clamp, one electrode on the right, and the second on the left sharp edge of the muscle, the free end of the muscle is drawn to the side of the cathode on closing the current,

and to the side of the anode on opening it, because in the former case only those fibres of the muscle on the side in contact with the cathode contract, while in the latter case only those on the side in contact with the anode are thrown into action.

The experiment may be performed in another manner. The muscle is divided by a cut, terminating a few millimètres beneath the clamp, into two longitudinal halves, these being held apart by means, for example, of a glass rod, on which the muscle rests like a rider. On now closing the current only the half situated on the side of the cathode contracts, on opening it only that situated on the side of the anode. If we now change, by means of a swing, the direction of the current, the closing and opening contractions also change place. Instead of the sartorius we may take other muscles, whose fibres run parallel through their whole length.

The placing of the electrodes has great influence on the success of the experiment. It is true that we may, even when the electrodes are by chance applied successfully to the muscle, remark, that the closing contraction gives to the latter a direction different from that given by the opening contraction; but a satisfactory result is obtainable only with a definite position of the electrodes. This is in most cases soon found, if we only take care that the electrodes reach merely to the sharp edge of the muscle, and touch its broad anterior or posterior surface as little as possible. In the second place, the intensity of the galvanic current, at least in muscles of great irritability, must not be too great. I generally employed one cell of Daniell's, the current of which could at pleasure be still further weakened by means of a rheochord. With a feeble current we sometimes obtain, with a definite position of the electrodes, only the opening contraction, and on inverting the current the closing contraction on the same side. If we then displace a little the electrode lying on the other side, closing contraction is again produced on the one, and opening contraction on the other side of the muscle. This is satisfactorily explained by the fact, that of the superficial muscular fibres some lose their irritability earlier, others later. If now the one electrode touch a group of muscular fibres, which have already lost their irritability, while the fibres situated at the other electrode have still retained theirs, only the latter contract, and it depends upon the direction of the current whether this takes place with its closing or its opening.

The experiments succeed as well with normal muscles as with those poisoned with curare. They prove that the irritation in the muscular fibre on closing of a constant galvanic current takes place at the negative, on opening at the positive pole. We possess, at the same time, in our preparation a physiological rheoscope, which, as well as the magnetic needle, is capable of indicating not only the presence, but also the direction of a magnetic current.

LETTERS, &c.

ON THE CAT OF THE ANCIENT GREEKS. Note by PROFESSOR ROLLESTON. OXFORD, *April* 16, 1868.

IN a book, with the existence of which I became acquainted a few days ago by a reference in Aubert and Wimmer's new edition of Aristotle's *Historia Animalium*, and which, through the kindness of Mr Sclater, I have had put into my hands this day, I have come upon certain statements which confirm not only certain of the conclusions, but also certain of the conjectures put forward by me in the *Journal of Anatomy and Physiology*, Nov. 1867. This book is Dr Erhard's *Fauna der Cycladen*, Leipzig, 1858. From it I learn that the *Mustela Foina*, the White Breasted Martin, the animal which in my paper I strove to show was the domestic mouse-killer of the ancient Greeks, is common now in all the Cyclades, and in some of them actually has the old Greek name, ἴκτις, at the present day. The Polecat, *Mustela Putorius*, and the Ferret are not members of this Fauna; neither could Dr Erhard find the Genet there. I will not trespass upon your space, which I fear must be already overfilled, by pointing out the bearing of these statements upon those advanced by me in your last number. But I will take this opportunity of saying that Dr Erhard's little volume deserves to be better known than it is at present in England. Besides giving us an excellent example and a "simple case" for the study of the rationale of the Distribution of Species, it teaches us the very important, and not a little needed lesson of caution, in receiving Catalogues of indigenous animals of any area, however small and accessible, as being necessarily exhaustive. Though the vegetation of the Cyclades is (p. 7) of such a character that a hare can hardly hide itself from the eye of the eagle, and though at first Dr Erhard was (p. 8) inclined to think their mammalian Fauna was as exclusively Adullamite as that of a coral island, he has, *after an investigation of several years*, given us a list of no less than sixteen land mammals, amongst which there is one new and previously undescribed species, the *Ægocerus Pictus*, the Ibex of the Cyclades. The very general distribution of the Rabbit, which in its wild state here is as large as the Hare or larger, goes some way towards showing that it was indigenous in the area of the Cyclades, as it is supposed to have been in the Balearic islands, before it was broken up into an Archipelago. But at the same time it is the harder to understand how Aristotle and how the Greek *gourmets* who, ζῶντες ἐν πᾶσι λαγῴοις, must have known how different a rabbit's flesh was from a hare's, if they had ever eaten it, could have failed to distinguish the one animal from the other, the rabbit being

now most abundant there, and having made the Myconos, so often mentioned by these ancients, into a honey-comb with their burrows. But in their days these islands were richer in population, an occasional massacre of Melians having been as nothing to the constant operation of Turkish barbarism; and if, as I have striven to show, this larger population had in domestication, house by house, such an enemy of the Rabbit as the Marten is, we have some sort of an explanation of the absence of the mention by them of an animal as existing in the Cyclades in classic, which must all but certainly have existed there in geological, as it does also in our own times. The islands, I may add, were probably or certainly, better wooded then than now; and trees favour the multiplication of the rabbit less than they do that of its many and various enemies.

2. In my paper I said at p. 58, "In the East the Felis took both the name and the work of the rival it supplanted." It is possible that I should have been right in making this statement more extensive, and in saying that the Cat of the Egyptians took not only the name γαλῆ, but also the name ἴκτις of its predecessor in the Greek house. For I find from a passage of Tzetzes, *Chil.* v. 8, quoted by Bochart, *Hierozoicon*, I. 986, 57, that this authority, if so we may call him, called the αἴλουρος by the name of ἴκτις. The passage from Bochart runs thus. "In Hesychio voce κτιδέα, κτίς ἐστι ζῷον ὅμοιον γαλῇ, viverra est animal feli simile. *Proinde putavit* Tzetzes esse felis speciem, quod his verbis diserte asserit Chiliadis quinti capite octavo,

ἴκτις δὲ ζῷον καὶ αὐτὸ τελεῖ (l. πέλει) ὀρνιθόφαγον
χερσαῖον καὶ τετράπουν μὲν, ὃ αἴλουρον καλοῦμεν."

But I am inclined, as I think Bochart was also, to consider these lines to be so worthy of their author as to be unworthy of any attention from us. And it is interesting to note that, in a Basle edition, of the year 1546, of Tzetzes' works, the first and, to the credit of human nature it should be added, also, up to 1826, the last independent edition of this portion of his works, some of which, happily, still remain unprinted, there stands opposite these lines the following Latin note: *Alii mustelam rusticam* seu viverram.

3. If I understated my case in this instance, I overstated it in another, when I said (p. 60) that the Cat will *never* take to burrows in the way of refuge. I have already said, in this paper, that in drawing up Catalogues and making up Faunæ, it is wise and well to avoid universal negatives. It would have been well if I had had this precept before my eyes in a more generalized form when I wrote my last paper; for I have since been informed by two good observers, that they have each of them known a cat take to Troglodytism. In neither of these cases, however, did the animal profit much by doing what it could not have been expected to do.

4. At page 57 of my paper, the word mark should have been mask.

PROFESSOR HUXLEY'S HUNTERIAN LECTURES.

PROFESSOR HUXLEY'S sixth course of Hunterian Lectures has been devoted to a general review of the Invertebrata, and he has given an admirable *resumé* of all the latest rasearches which have been carried on in that very wide field. He has not, however, found that even the most recent discoveries render necessary important modifications in that system of classification which he has been in the habit of employing for years past in his lectures at the School of Mines. He still reckons the Annuloida as a group distinct from all the higher Annulose animals; and containing together with the Rotifera and Scolecida, the Echinodermata also. The Gephyrea are still separated from the last-named group, and constitute a division of the Annelida. The Mollusca and Molluscoida form the other primary divisions, the latter containing the Ascidioida, Brachiopoda and Polyzoa. The Infusoria (with which are associated *Noctiluca* and *Acineta*), are separated from the rest of the Protozoa, which last embraces only the Monerozoa, Protoplasta, Radiolaria and Spongida.

The lecturer opposed the proposition of Professor Haëckel of Jena to form an intermediate *Regnum protisticum* between animals and plants; referring his Diatomea and Flagellata to the vegetable world, and retaining amongst animals the other groups of Haëckel's intermediate kingdom.

The remarkable form *Protogenes*, discovered by the last-named Professor, the structure of which is less complex than that of a human colourless blood-corpuscle, was brought forward as a striking instance of the absurdity of that opinion which attributes such wonderful powers to "a nucleus," and as showing that organization is a product of life.

Professor Huxley dwelt much upon the Scolecida, especially the parasitic groups.

Among the more novel or strange forms, may be mentioned the *Bilharzia* of Dr Cobbold, a very dangerous Trematode happily confined to Africa. It is one of the greatest causes of disease in the Valley of the Nile; half the population being more or less injured by it. It infests the great blood-vessels, where it may attain the length of half an inch. The female is much smaller than the male, and lies perpetually embraced in the concave side of the body of her spouse.

The Nematoid worms were very carefully described, and a hearty tribute paid to the excellent labours of Dr Bastian on that class.

The Professor now unites with it those forms which were formerly held to constitute a distinct group—the Gordiacea.

There is a very peculiar Nematoid named *Spherularia*, which has been investigated by Sir John Lubbock. Its nature is not yet thoroughly made out, but it appears probable that the genital sack of the animal comes to suffer an extreme prolapsus, and that it then

attains a size utterly out of all proportion to the rest of the animal. In *Ascaris Nigrovenosa*, which inhabits the lung of the frog, a real "alternation of generations" seems to take place; two different modes of *sexual* reproduction appearing to occur alternately—a condition as yet utterly unparalleled.

In describing the anatomy of the Lobster as a type of the Arthropoda, the lecturer detailed the interesting series of problems which have of late arisen as to the homologies between the structure of the arthropod eye and the vertebrate retina, and he thought it not improbable that this homology would be found to be complete. It will be so if the optic nerve fibres of the Arthropods can be demonstrated to ascend to, and to be connected with, the distal ends of the optic rods.

Amongst the Crustacea were noticed those very aberrant Cirripeds, the *Rhizocephala*. These are parasitic on the soft abdomen of the hermit-crab, and have the appearance of small tumours. There are no appendages, there is no heart; and it is doubtful if there is even an alimentary canal; while the body is attached to its host by a process which branches out into the substance of the latter. The true nature of these creatures could never have been even suspected but for their process of development. The larva is at first active with three pairs of locomotive appendages. Having attained its hold on a hermit-crab, it thrusts into the body of the latter its antennary organs; then these grow out in an arborescent manner in the crab, while the animal loses its other appendages, and assumes the adult condition.

The genus Limulus is now associated by Professor Huxley with Pterygotus, &c., in the group *Merostomata*. The Trilobites were declared to present obvious resemblances to Limulus, to Serolis, and to Saphirina, and the general genetic relations of the groups of Crustacea were traced from some ancient *Nauplius* form through the Copepoda to the Branchiopoda on one side, and to the Merostomata on the other.

The greatest novelty in the class Insecta was the mode of reproduction in a certain dipterous insect discovered by Nicholas Wagner. In this Hessian Fly the larva gives rise by internal gemmation to other larvæ, and each of these again to others. In another dipterous insect (the common flesh-fly) a great part of the larva liquefies, while small masses of formative tissue attached to the tracheæ, and called "imaginal disks," give rise respectively to legs, wings, eyes, &c., and together build up the ultimate form of the adult by their growth and mutual approximation. No such process is known to occur in any other group.

As to the general affinities of the different sections of the Invertebrata, the latter were stated to form two series diverging upwards from the lowly Monerozoa. One line is very continuous, namely, that which leads up through other forms of Protozoa to the Infusoria, and thence by the Rotifera to other Annuloida, and finally to the Annulata and Arthropoda. The second line is much more interrupted; the Monerozoa and Spongida being separated by a wide

interval from the Cœlenterata. The last group, however, being once gained, the route is comparatively easy thence to the Molluscoida, and from the latter to the Mollusca.

The ultimate goal and final end of all zoological classification is the arrangement of the various groups according to their true genetic relations. This, however, is now and will long be quite impossible; classification as yet being almost wholly confined to the logical method, and to the method of gradations.

The Hunterian Lectures were this year very largely attended, and the number of students who availed themselves of this valuable opportunity of gaining zoological knowledge was, we believe, unprecedented.

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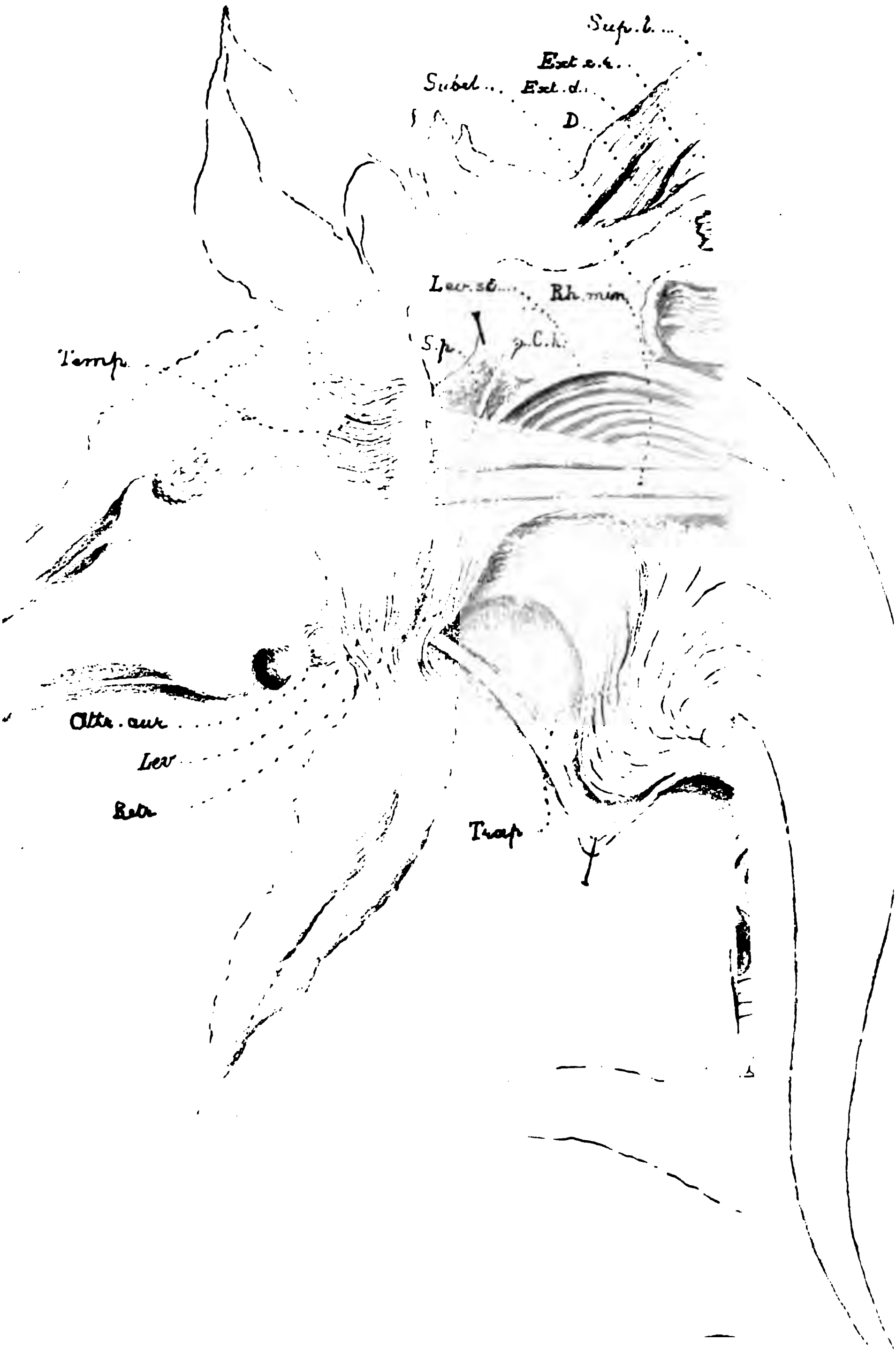
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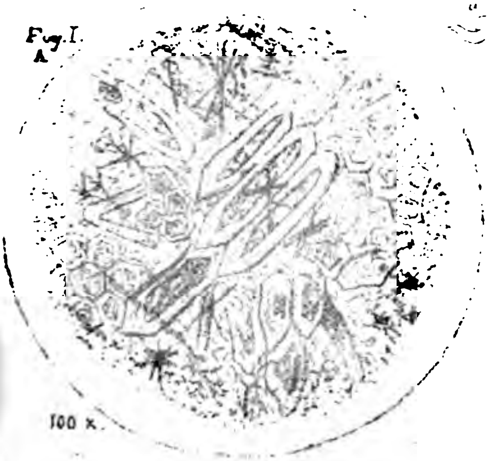

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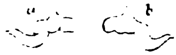

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Fig II. A

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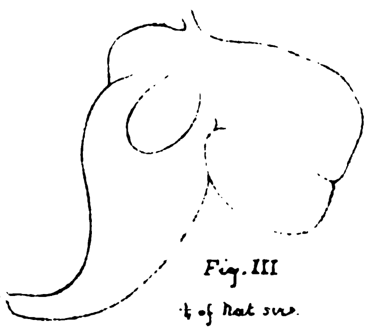

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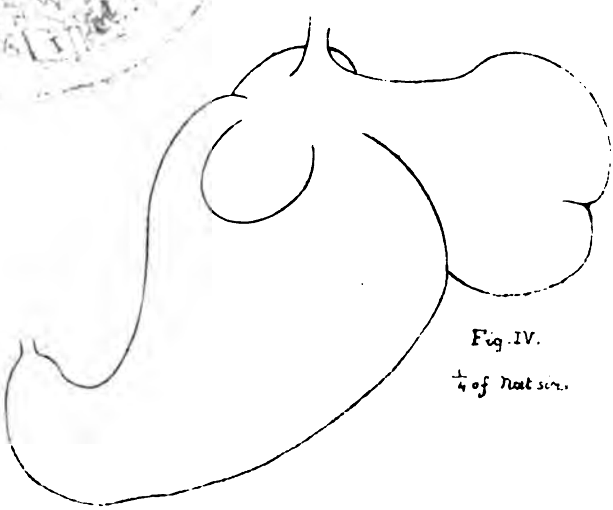

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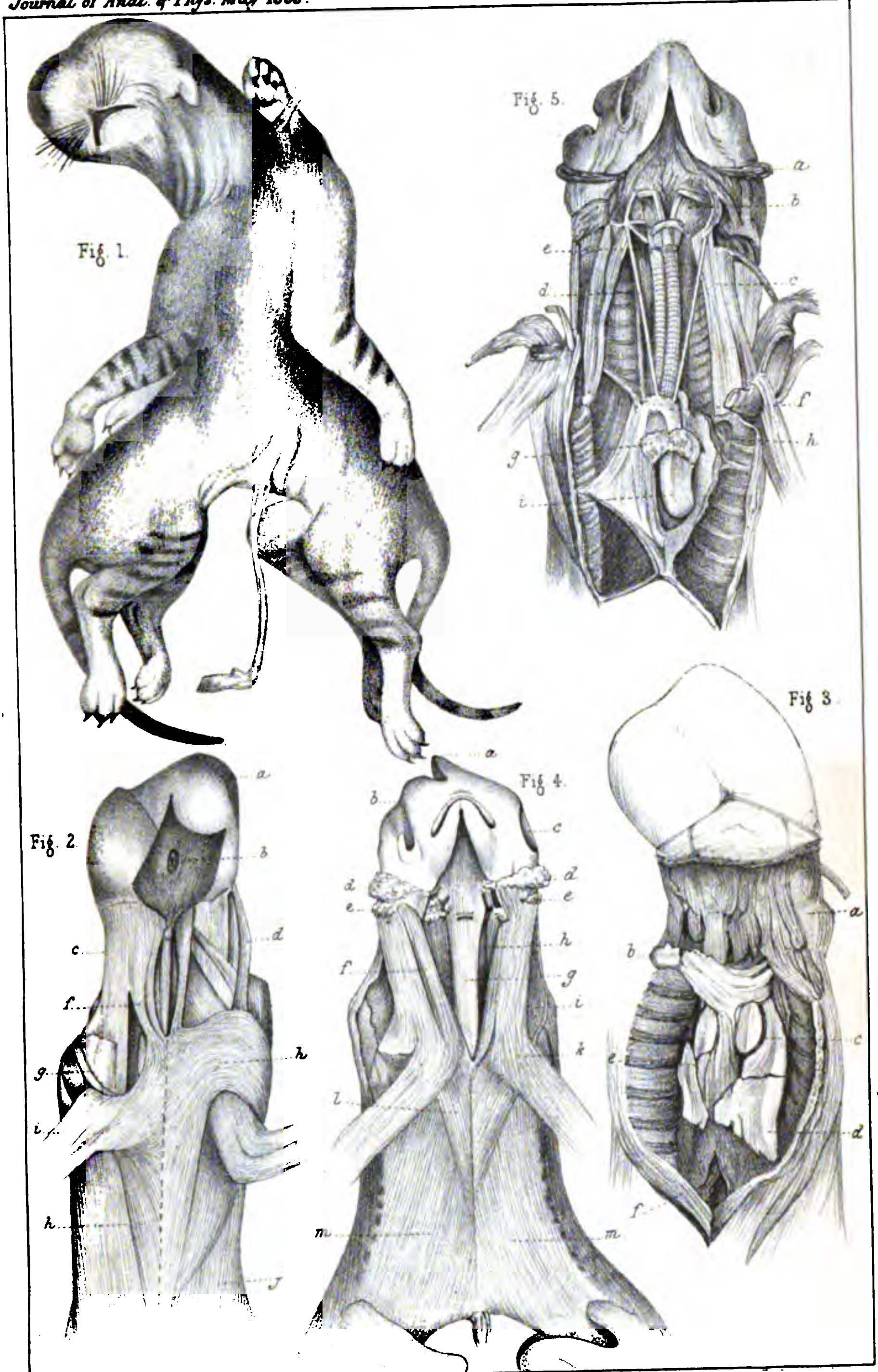

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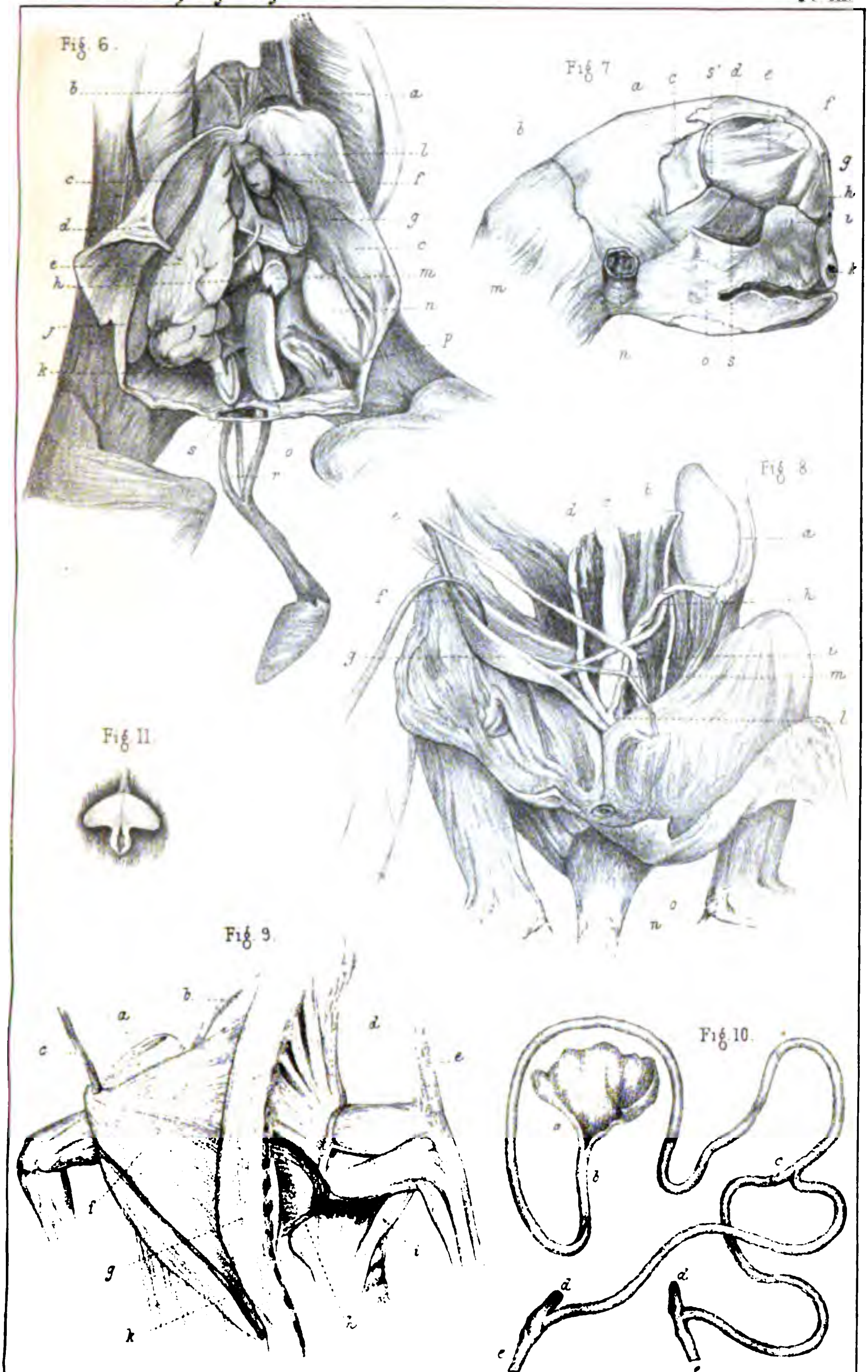

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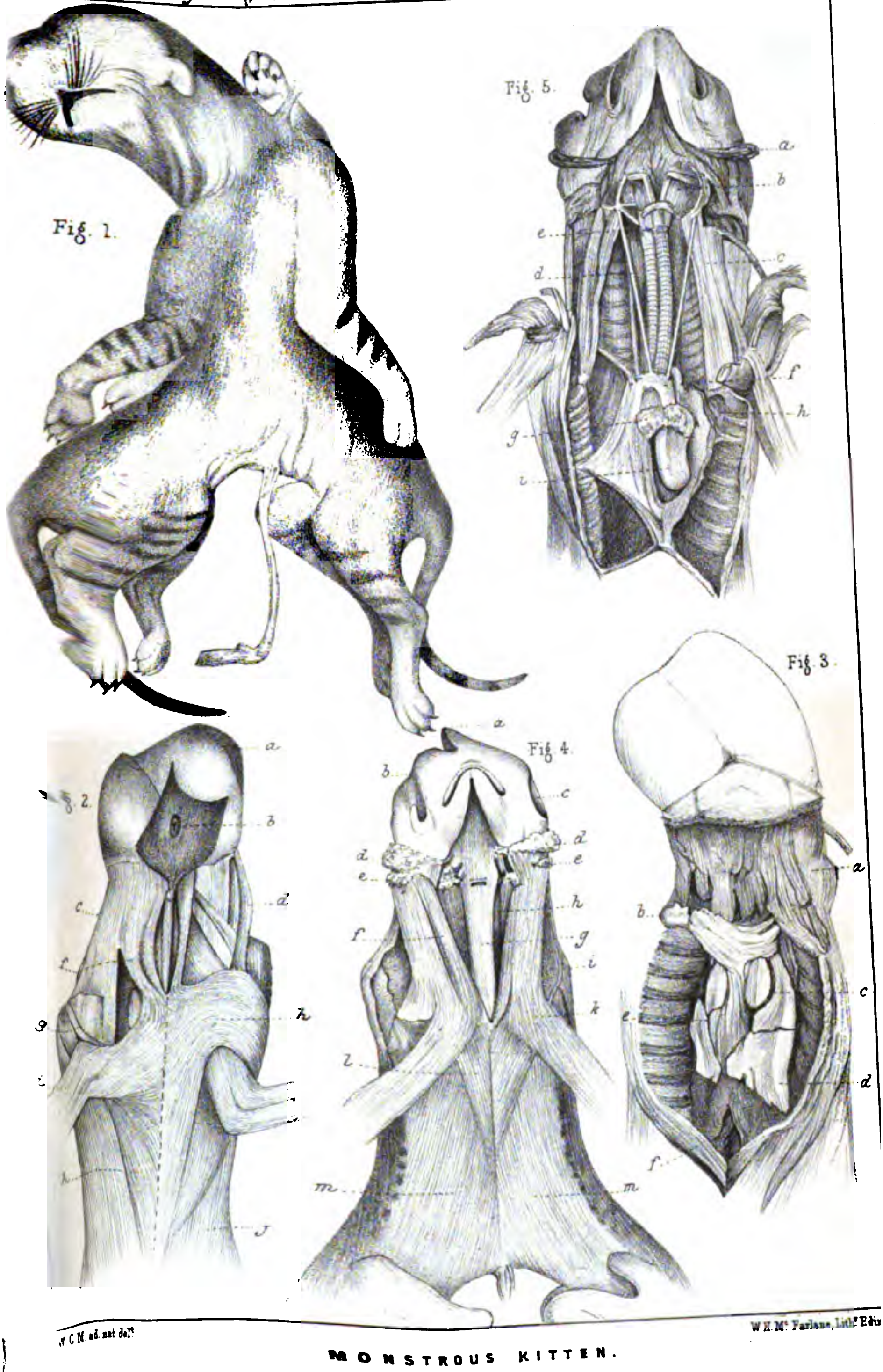

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